MANAGEMENT EDITION

THE Petroleum Engineer

Exploration
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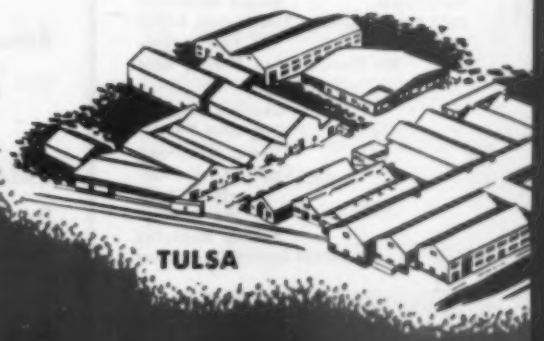

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MANAGEMENT EDITION

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OIL AND GAS PIPELINING EDITION

Draw the Battle Lines!

When the President vetoed the natural gas bill because Senator Case objected to a campaign contribution, a committee headed by Senator George of Georgia was set up to investigate any objectionable features in connection with the bill's passage.

Investigation of the case of Senator Case has turned up no other such incidents in the passage of the Fulbright-Harris Natural Gas bill. The report from the investigating Senators declared that it was still ethical to lobby and ethical to contribute to campaign funds but the two must not be combined. It appears that since campaign contributions are evidences of approval of what an office holder has done, one must not contribute too close to the time he does it.

Time-splitting ethics combined with political awareness gave the nation, especially the petroleum industry, one of the worst blows it ever had. There is no disease so quickly and thoroughly destructive to our individual capitalist system as price controls.

The petroleum industry still has the job of freeing the gas producers from Federal controls. How do we go about it?

We must first face the fact that there is no possibility of a new bill in this Congress. Gas producers will have to ride out another year at least and it will be the worst year since the Supreme Court handed down the decision in the Phillips Case. Everything that is done or not done under FPC controls will be important in the coming attempt to remove them. We have an opportunity now to document our petition for relief.

Document
Our Petition

Second, we suggest an opinion poll by states. Just where are we with the consuming public on this question? Are consumers in favor of price controls on natural gas production? What part of their gas bill do they think goes to the natural gas producer? Do they believe price controls will limit supply? U. S. consumers may be more inclined to depend on competition than on a Washington bureau to set the price for natural gas.

Take
Opinion Poll

Third, as members of the petroleum industry, and of the organizations in it, let us limit our petitions to Congress to vital questions where laws and regulations would be helpful. Freedom of operations carries responsibility to the nation and to the industry as a whole. Let us fight our battles on home ground and not in the nation's arena.

Limit
Our Petitions

Also we can employ stricter standards in public contributions. Members of the petroleum industry have a reputation — largely undeserved — of throwing money around. It would be good discipline to make more thoughtful decisions on contributions and gifts.

Study
Contributions

Along with this should come a serious effort to inform the public exactly why money was spent for this or that objective. Even contributions for scholarships, which appear self-explanatory, should be protected with clear statements of purpose. Public opinion respects thoughtful expenditure — either by companies or individuals. There is little patience for wasteful handling of money.

Explain
Purpose

We need to build up public understanding of the fact that freedom from Federal control for the natural gas producer is fundamental to maintaining our economic system. This could be done not only by committees but by individual companies. Many concerns have helped the whole industry with extraordinarily penetrating campaigns based on their own operations.

Build
Understanding

The seventh item on our list is to keep informed. We were so busy promoting our own facts and figures that we didn't hear our opponents arguments. We must listen more to learn what we're up against, and what the answers are.

Keep
Informed

The war between people's enterprise and government enterprise does not begin or end with the natural gas bill but freedom from Federal control for the gas producer is a mighty important battle. If we lose it, we must eventually surrender control of the petroleum industry.

—ERNESTINE ADAMS

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- Valve stem, hardened stainless.
- Packing, special Marsh "Marpak" moulded ring.
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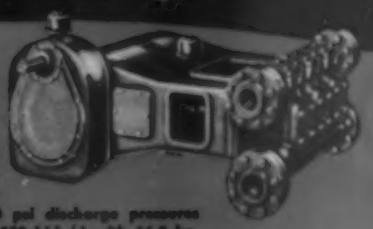
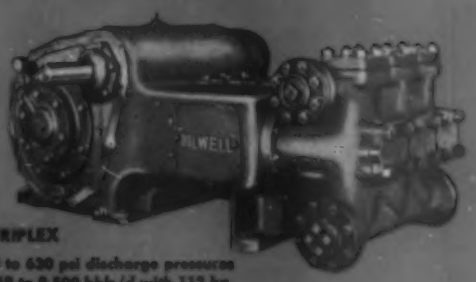
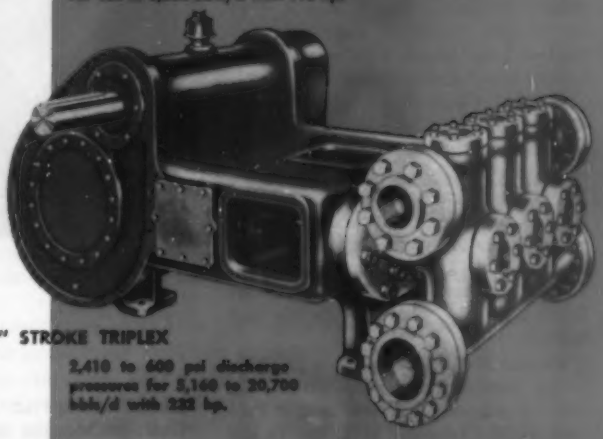
. . . representing the most complete line of horizontal power pumps in the industry . . . provides a wide range of plunger diameters to best suit your operating requirements with minimum input horsepower. A choice of material for fluid-ends, plungers and valve service is available.



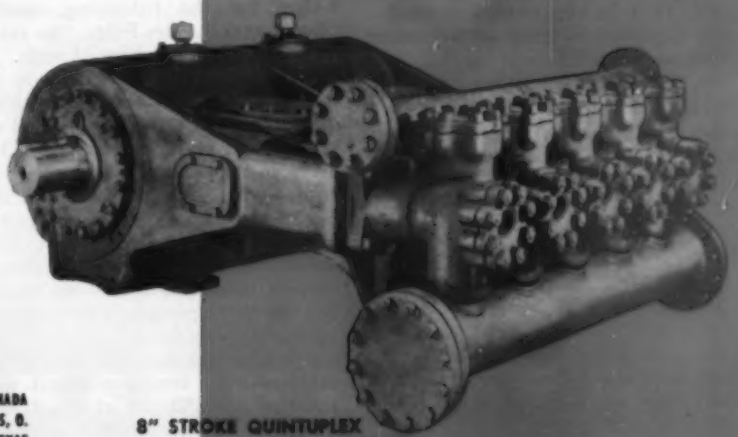
4" STROKE TRIPLEX
1,000 to 400 psi discharge pressures for 560 to 4,850 bbls/d with 66.8 hp.



6" STROKE TRIPLEX
5,650 to 630 psi discharge pressures for 462 to 8,500 bbls/d with 112 hp.



8" STROKE TRIPLEX
2,410 to 600 psi discharge pressures for 5,160 to 20,700 bbls/d with 232 hp.



8" STROKE QUINTUPLEX
3,540 to 1,270 psi discharge pressures for 7,340 to 20,400 bbls/d with 490 hp.

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Petroleum Profile

"YOU don't learn all about oil production by working from 8 to 5. You've got to put in plenty of extra hours." So declares Everett Roswell Filley, vice president in charge of Texaco's Domestic Production Department.

During his rise into management, Filley worked many a night and weekend when he was in the field.

Everett was born in 1894, in the town of Filley, Nebraska (pop. 136), which was named after its banker-founder, Elijah Filley—the vice president's grandfather. When he was 8 years old, the Filleys moved to Okmulgee, Oklahoma, in the Indian Territory.

At the age of 14, Everett watched surveyors come in and stake out an oil well drilling site in the pasture land near Okmulgee. Then a derrick went up. Shortly afterward, oil was discovered and the plains were soon dotted with derricks and lease tanks.

In 1915 Filley was graduated from Baker University in Baldwin, Kansas. He had majored in mathematics, intended to go on in law. However, the unexpected death of his father (who worked for the Producers Oil Company, a Texaco subsidiary which was absorbed by The Texas Company in 1917) required him to return to his home in Tulsa, where his family had moved.

During his college vacation in 1914, Filley started his Texaco career. He was an accounting clerk in the Producers Oil Company at Tulsa. In the fall of 1915, he went to work as a full-time employee, learning all he could about oil production.

In 1926, Filley was promoted to division superintendent at Tulsa. Three years later, he was named division manager. He helped to assemble the leases and geological data for the drilling, in 1938, of the discovery well at the famous Salem field near Centralia, Illinois.

Filley was transferred to Houston in 1938 as assistant manager of the producing department. He became manager in 1947 and, in 1949, was made general manager. Four years later, he was elected vice president in charge of domestic producing.

On a typical day in his Manhattan office, Vice President Filley may make decisions concerning such matters as: Offshore drilling in Texas Gulf waters; exploration in a new area of the Rocky Mountains; a bid for unexplored acreage in Louisiana or the Gulf of Mexico; the departmental budget for the following month. "Every week," states Filley, "we authorize the drilling of about 35 wells."

EVERETT ROSWELL FILLEY
Vice President
The Texas Company

At conferences, Filley listens to all the facts, and asks several searching questions. Then he makes his mind up quickly and stands firmly behind his decision. His fairness and steadiness in encountering problems have won the esteem of associates. Says the executive of another major oil company: "I've known Everett for 20 years. He always remains calm and cool — no matter how heavy the pressure. That's why he accomplishes so much."

The vice president is a director on the boards of several principal subsidiaries and affiliates of The Texas Company. He also serves as an officer of a number of these companies. As president of Texaco Exploration Company, a wholly owned Canadian subsidiary, Filley guides all Texaco producing operations in Western Canada. He spends a total of four months out of every year away from Texaco's Manhattan headquarters. Annually, he visits the Producing Department's six geographical divisions in the United States as well as the Canadian operations. "Our job is to find over 150 million barrels of new reserves every year," he says. "If we do this it means that we find more oil than we take out of the ground during the year. Thus, we're always building a backlog of reserves for the future."

Busy as he is, Everett Filley devotes much time to college and church activities. For many years, he has attended board meetings at Baker and Drew Universities as a trustee. Recently, he was elected to the board of trustees of the Methodist church he attends in New York City. He also serves on the board of managers of the Brooklyn Methodist Hospital.

Although Mr. and Mrs. Filley now live in Connecticut, whenever he goes to the Southwest, he fits in some rewarding visits with his four children and five grandchildren.

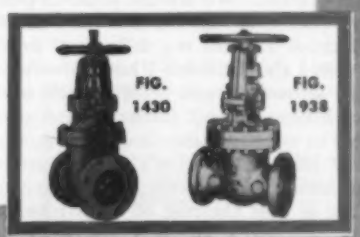
LUNKENHEIMER OPENS

New Modern IRON and STEEL VALVE PLANT

THIS 400-foot machine bay—one wing of the new Lunkenheimer plant—houses the industry's most up-to-date precision equipment for manufacturing iron and steel valves.

Here, old-world craftsmanship and attention to detail—a Lunkenheimer tradition since 1862—are combined with modern production facilities to assure the highest standards of quality. Lunkenheimer Iron and Steel Valves are world-famous for long life and low maintenance. Their shoulderless seat rings will not warp, and the gates have exclusive machined disc guides that eliminate "chatter" and reduce wear.

This entirely new iron and steel valve plant is located next to the Lunkenheimer bronze plant, which was completely modernized a few years ago in a sweeping $3 million program. Together, they give you the finest, most dependable valves that man can build or money can buy. The Lunkenheimer Co., Box 360, Cincinnati 14, Ohio.



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THE CONFERENCE TABLE

What This Industry Needs . . .

When Jack L. Hamon, first independent operator to be chairman of the board of American Petroleum Institute, was named "Man of the Year" by Texas Independent Producers and Royalty Owners Association, he reached a unique spot in the history of the oil industry. There are few indeed looked upon with favor by so many persons of differing opinions in the petroleum business.

Without sacrificing his position on any single problem that confronts the industry, he has been able to subordinate irritations and look toward the goals that are vital to the industry as a whole.

TIPRO's "Man of the Year" made this appeal to his fellow independents at the annual meeting in Dallas, Texas:

"Maybe I should have my head examined because I have been involved in nearly every oil association, local, state or national, that has been organized, and I don't regret it. I think I have learned this much: There are justifications and reasons for all of them.

"When I say we need unity in our industry, I am deadly serious about it. We need the help of the refiner in Michigan and Wisconsin, the jobber in New England and the pipeliner in Missouri, and the filling station owner in Oregon. Don't stay out of any organization because they have major oil company men in them. Meet them, talk to them, join them and work with them. You need their help and they will be glad you are on the industry's team.

"You don't need to change your ideas on any controversial question; you might even get them to agree with you, when they get to know you and respect you. Sure, it will cut into your fishing and golf, but you will be rewarded by knowing that you are putting something back into your industry that you are a part of. Your help is badly needed, and if you will give it, you will be richly repaid in new friendship and in new experiences."

Mr. Hamon was concerned about the industry's public reputation. "We are the lousiest public relations men it is possible to be," he told his audience.

"I think I know my fellow oil producers as well as anyone; I should, since I have been around them all my life. I know you are good church and school workers, good husbands and fathers, good civic workers, good givers to worthy causes and good Americans. To survive in our business, a man's word must be good, he must have honesty, character and integrity. What you don't realize is that the rest of the United States has an entirely different opinion. They think we are a bunch of rich, overbearing braggarts with a tax gimmick. Unless we change that unfair attitude about us we're going to lose our depletion allowance, and generally go down the drain."

You Can't Win

Another recent speaker, S. C. Bartlett, Texaco vice president, also developed this theme. As a result of poor public relations, he said in a talk before the Ohio Petroleum Marketers Association: "Seldom, if ever, has our industry been subjected to as many irresponsible charges as are now being leveled against us. On one hand, we are accused of being a monopoly and having no price competition; on the other hand, we are accused of being so competitive price-wise that we drive dealers out of business.

"Before one Congressional subcommittee the claim is made that we are profiteers and gougers; before another subcommittee the claim is that we start price wars in order to move products regardless of profit. Prices are held to be too high in some areas, too low in others; prices are too uniform and not uniform enough."

●

INSURANCE, or the difficulty of working out coverage, has been one of the big hindrances to development and use of peacetime atomic energy. Insurance can also work many — and sometimes unexpected — hardships on the oil operator who goes into foreign areas. William F. Cushman, vice president of American Foreign Insurance Association, gives management some sound pointers on insurance of foreign operations in his article on page E-18 of this issue.

●

HIGHWAYS have a key role in peace and war, in the U. S. A. and in New Zealand, in financial and social aspects of modern life. The present bill before the U. S. Congress provides more than $50 billion to be spent on highways. In "Roadways of the World" (Page E-23) the managing director of Royal Dutch Petroleum Company reveals the world-wide problem of roads and what they mean to people. Seeing what others are doing can help each country on this problem.

Those Conference Winners

Do you know what a conference is? Do you know how important they are? Do you know how to WIN a conference?

William D. Ellis and Frank Siedel have written a fast-pace volume on "How to Win the Conference"* that should be "must" reading for top management as well as ambitious young supervisors who want to go on to bigger things.

"You take part in a conference every day. It may be just a chance meeting at the elevator button. It may be the interruption that calls you out of a big meeting. Just be aware that whatever it looks like, it is a contest. With that understanding your business career will take on new sharpness, directness, and vitality."

One thing about this book on self-improvement, whether you learn anything or not (we'll bet you do) you will be entertained. You'll learn how Augustus Swift, the meat packer, kept in business when creditors were closing in on him. You'll learn how important it is sometimes to lose one. You'll learn there is a time to rejoice at trouble. And what you learn may help you in those conferences you have every day.

*Published by Prentice-Hall, Englewood Cliffs, New Jersey, $3.95.

"The price of justice is eternal publicity." — ENOCH ARNOLD BENNETT

What Management Likes

Reprint requests have been coming in large numbers for several of our recent management articles.

"What Makes a Man Work" by Dr. A. Q. Sartain has become one of the most popular. A reorder on reprints make this article available again (prices on page A-14).

Seldom have we had as many requests for reprints as for our series on Communications by Dr. Dennis Murphy. The articles began in December and will run several more months. Reprints will be made when more articles have been published. The file of requests is growing daily and if you are interested we'll put you on the list to receive information about the reprints.

"The Philosophy of Reading" has inspired a number of requests for copies.

"Unrest Among Engineers" has also been of interest to management as reprint requests indicate.

Several readers have been kind enough to approve our editorial for management. H. C. Hanson of Oceanic Oil Company, Bakersfield, California, writes: "I am very pleased with your articles on supervision management, personnel and communications."

Another reader, Joe B. Smith, Pipe Line Development Company, Cleveland, Ohio, says: "Reading the March number of The Petroleum Engineer it all at once occurred to me that you have apparently adopted a new policy in publishing this magazine.

"Articles such as 'The Philosophy of Reading,' 'How to Manage Sentences,' 'Unrest Among Engineers', recognize the need of helping engineers to a broader viewpoint. I think it is fine. Congratulations."

Reader V. E. Bohme, The Petroleum and Natural Gas Conservation Board, writes about "Unrest Among Engineers": "Alberta is no exception to the current shortage of engineers. I believe that one answer will be to develop our engineers into *good* supervisors and make use of many more engineer-directed technicians.

"Your article on page E-6 of the March *Petroleum Engineer* mentions the Engineers Council for Professional Development. This sounds like a step in the same direction that we are hoping to move."

A Quick Review of 1955

Humble Oil & Refining began its annual report this year with an overall review of U. S. operations as Humble saw it. This included the three graphs below. The company, an affiliate of Standard Jersey, documented the case of imports vs. domestic supplies.

Petroleum demand in the United States increased more than 650,000 barrels daily in 1955, the largest annual gain since 1951. Domestic production of crude oil increased 465,000 barrels daily, and imports increased 200,000 barrels daily. If imports had increased only in proportion to domestic production, as recommended by the Cabinet Committee on Energy Supplies and Resources Policy for reasons of national security, they would have advanced only about 81,000 barrels daily. In that case, the additional demand for domestic crude oil could easily have been met from the large reserve producing capacity, estimated at more than 2,000,000 barrels daily in 1955. Much of this reserve capacity is in Texas, where prorated wells continued to be restricted by lack of markets to about 53 per cent of their maximum efficiency rate of production, as they were in 1954. Crude oil production in Texas increased to 2,900,000 barrels daily, with new well completions absorbing most of the gain.

Drilling activity in the United States went up about 5 per cent, compared with a gain of 8 per cent in demand. About 56,700 wells were completed in the United States during 1955.

The Best Economic Documents

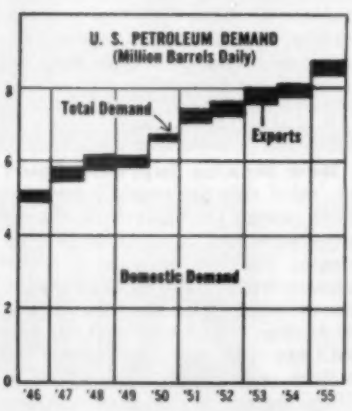
This issue carries the ninth annual report survey of petroleum companies whose stock is sold on open markets (Page E-2).

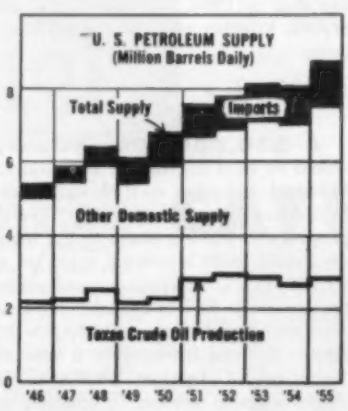
These annual reports are the best economic documents of American business and industry available. Each records the effects of trends, political and economic, upon one particular company.

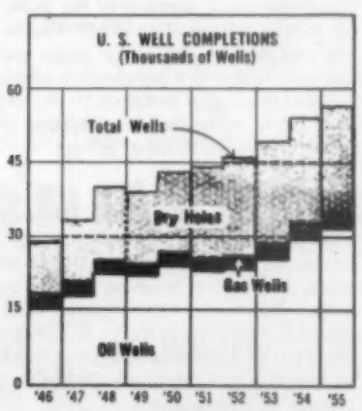
We have little patience with the attitude that financial reports are manipulated for improper purposes. Every company operates under the same laws and it is completely fair to chose the course most advantageous to the company just as an individual reports any possible deductions for his income tax.

As a common example, some companies capitalize intangible development costs and lease rents; others charge them to expense. To each firm one method appears to be more suitable to its organization. In general, the annual reports of the oil industry are amazingly frank and revealing. They have grown more so in the years since our first survey in *The Petroleum Engineer* (Page 167, April, 1947). Most of them contain clear, highly interesting discussions of finance and operations, including managements' opinions and decisions about the world they move in.

If our present system can be called "people's capitalism", company annual reports are the people's economic literature.







Courtesy Humble Oil & Refining Company

HIGHLIGHTS ★ ★ ★

Digest of News and Comment

ENI, the Italian government's oil company, may lose much of its power through pending Italian parliamentary legislation. Private oilmen contend that such a reduction of power is sorely needed to encourage faster development of Italy's resources. The bill, as presented by a parliamentary committee, poses an important issue this year.

★ ★ ★

Oil burner installations in the U. S. during February totaled 46,852, reflecting a 22 per cent rise above year earlier figures, estimates "Fueloil and Oil Heat" magazine.

★ ★ ★

Disputed Louisiana offshore boundary will get a U. S. Supreme Court test soon. Attorney General Brownell has given approval to the federal government to sue the State of Louisiana to claim lands beyond a 3-mile boundary. Louisiana called for bids in April on leases for a number of areas, including several beyond the 3-mile limit, on which federal leases are being offered for sale on May 15 by the Department of Interior.

★ ★ ★

Oil producers lost $150,000,- 000 last year, says TIPRO in an appeal to 22 crude oil purchasing companies asking that they hike crude price postings 60 cents a barrel. The organization figures that costs of finding and producing new oil in 1955 far exceeded its estimated value of $12 billions.

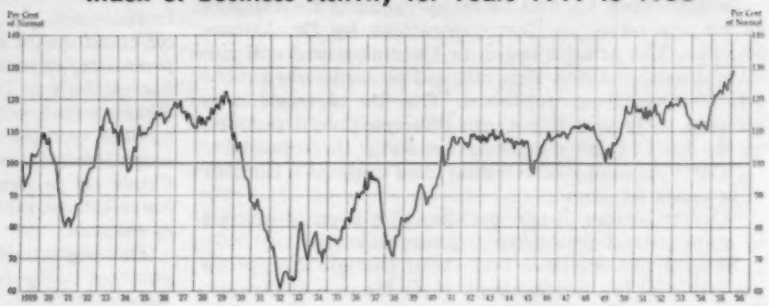
★ ★ ★

Smaller transistors — 20 of the new units fitting on a dime — are now being made by a leading manufacturer, the microwave telemetering and communications segment of the industry will be interested to know. The device operates in the audio range and has been tested in a pencil-sized amplifier that has a gain factor of 70 db, and is made to withstand accelerations of 20,000 times the force of gravity.

★ ★ ★

Industrial production showed more-than-seasonal gains during February, the Federal Reserve Board reports. Production is about 9 per cent above February, 1955 figure. Commercial exports from the U. S. in January were $1.2 billion, up $100,000,000 in a year, the Commerce Department reports.

Index of Business Activity for Years 1919 to 1956



—Compiled by Guaranty Trust Company.

Petroleum industry financing has been thoroughly "fogged," says J. Ed Warren, vice president of the First National City Bank of New York. The confusion in granting bank loans to gas producers and pipe line companies was created by the Presidential veto of the gas bill, which upset gas price contracts. As a result loans have much higher interest margins to protect against uncertainty of price. Warren termed the present situation as "one of utter confusion and unlikely to be resolved until the question is completely fought out through the courts; and/or clarified by the enactment of legislation."

★ ★ ★

Foreign trade, aid and invest- ments by the U. S. last year reached an all-time level. This country sent abroad in 1955 approximately $21.8 billions worth of its goods and services — a raise of nearly one billion dollars over the 1954 total. This included shipments of military aid valued at some $2.1 billions —about a billion dollars less than in 1954, but commercial aid exports together rose by about $2 billions.

★ ★ ★

A $30,000,000 refinery would be built on Hawaii Sand island, in Honolulu harbor — if Hawaii is permitted to sell the 200-acre strip. Hawaii proposes to sell the island to the highest bidder, with minimum price set at $3,500,000. U. S. congressional action is necessary to restore the land to Hawaiian jurisdiction, according to Attorney General Brownell in a letter to Secretary of Interior McKay. The island is about one-fourth underwater.

Texas has refused to pay in- terest on taxes paid by Tennessee Gas Transmission Company under the now-defunct natural gas gathering tax. A state Court of Civil Appeals granted the company a $1,140,906 tax refund, but would not allow payment of interest amounting to nearly $250,000. Tennessee Gas sued the state for tax recovery under the 1951 gathering tax act, declared unconstitutional by the U. S. Supreme Court in 1953.

★ ★ ★

Stockholders of Tide Water Associated Oil Company cast ballots May 3 to change the name of the organization to the Tidewater Oil Company.

★ ★ ★

College scholarships and fel- lowships made perennially by many oil companies and service organizations, indicate additional offerings this year. Unfilled demand for engineers within the industry may be motive for the increasing number of grants. University of Oklahoma has just announced fellowships valued at $7800 for graduate students in petroleum engineering being made by Shell, Atlantic Refining, Humble, and Lane-Wells.

★ ★ ★

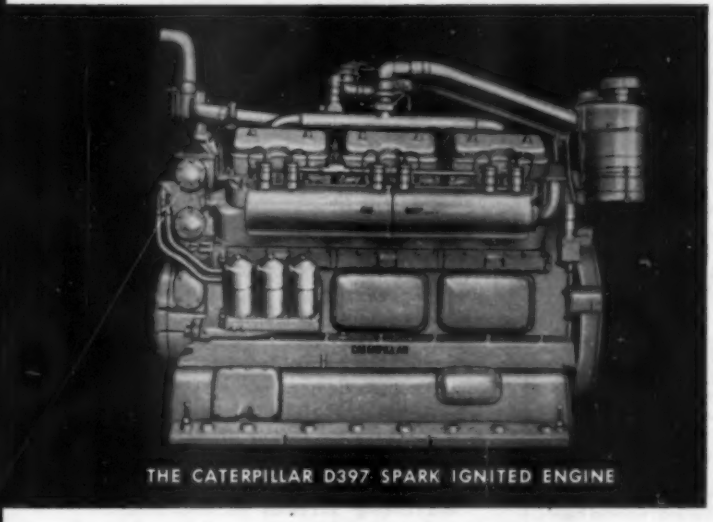
New Mexico Supreme Court has ruled that the state's 2 per cent gross income tax on revenue did not apply to seismic work done in New Mexico. The case concerned an appeal made by Seismograph Service Corporation of Tulsa, Oklahoma. The decision made clear that seismic work done by SSC was in interstate commerce. The decision should prove advantageous to a large segment of the seismic industry.

Announcing 2 CAT* Spark Ignited Engines

D397
400 HP
@ 1200 RPM

D375
267 HP
@ 1200 RPM

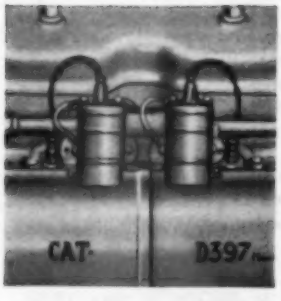
10:1 COMPRESSION RATIO for economical operation
SPARK COIL AT EACH CYLINDER for hotter spark, greater efficiency
LOW-TENSION MAGNETO for long, trouble-free life
MODERN HEAVY-DUTY DESIGN
PLUS OTHER ADVANCE-DESIGN FEATURES!



THE CATERPILLAR D397 SPARK IGNITED ENGINE

Developed to set new standards of efficiency and economy using low-cost natural gas, the D397 and D375 Spark Ignited Engines are the most recent additions to Caterpillar's line-up of modern, heavy-duty units. Wherever you put them to work, you can count on maximum performance with minimum maintenance. Conversion units are also available for diesels. Your Caterpillar Dealer, who backs you with prompt service anywhere and any time, will be glad to give you complete facts about this new power pair. See him today!

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.



A separate spark coil for each cylinder, featured in both the D397 and D375, provides a hotter spark for greater efficiency and permits the use of a low-tension magneto for long, trouble-free life. Advance-design features like this are the result of Caterpillar research and practical field experience—an example of Caterpillar leadership in action!

CATERPILLAR*

*Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

MODERN HEAVY-DUTY SPARK IGNITED ENGINES

Lower oil allowables have been set for Texas and Louisiana in May. Louisiana daily crude flow has been set at 749,866 bbl, a reduction of 38,902 bbl from the April level. The decrease comes as a result of a 4 per cent reduction in the "depth bracket" formula used to set allowables for individual wells in rough proportion to their depths. Texas producers will take a 78,357 daily oil cut in May, as a result of Railroad Commission order. The Texans set the allowable at 3,290,224 bbl daily, retaining the 16-day flow statewide.

★ ★ ★

Welfare and pension plan administrators should be required to file detailed and audited annual reports with the government. That recommendation will be made in a forthcoming report of a Senate labor subcommittee studying growth of these programs in the past 10 years. The proposal affects about 30,000 companies in the U. S., as well as hundreds of labor unions, who have set up welfare and pension projects.

★ ★ ★

Cosden Petroleum Corporation's merger into the W. R. Grace & Company appears nearer, with a proposal calling for the exchange of 102.5 shares of Grace common stock for each 100 shares of Cosden stock. The deal will be considered by stockholders at a meeting in May. Cosden President, R. L. Tollet, under tentative agreements, would continue as head of that firm with headquarters in Big Spring, Texas. A $3,000,000 styrene plant is now under construction by Cosden in Big Spring.

★ ★ ★

Texas independent oil men have joined to oppose a bill now before Congress requiring merging companies to give advance notice of their merger plans. A resolution of the Texas Independent Producers and Royalty Owners calls the bill "harmful to small operators and will not accomplish the intended purpose of strengthening necessary antitrust laws."

★ ★ ★

Oil fever is hitting Syria, with the government considering a series of refinery construction offers and negotiating with American interests for exploration rights in the northern part of that country. The Czechs are reported to have the contract, with a "ready-to-assemble" refinery to use crude from pipelines that carry oil across Syria to the Mediterranean. Nearly 30 bids were offered for the 20,000 bbl plant.

Navy's claim to oil reserves is getting larger, a recent memoranda to Congress reveals. Basically, the Navy now claims: (1) Oil beneath naval bases in the continental U. S.; (2) oil beneath parts of the inner belt of the offshore lands, which was supposedly returned to the states in 1953, where there are naval shore installations; (3) oil beneath at least part of the outer belt of the submerged lands, and (4) the right to declare additional areas as naval petroleum reserves and to claim the oil beneath the reserves.

★ ★ ★

Escalator and favored nation clauses will be ruled out of future gas producers' contracts with pipe lines, if the FPC adopts a proposed rule. The commission will accept views and comments until June 1 on a ruling expected to go into effect July 1 providing that "no contract will be accepted for filing which contains provision for the adjustment of price of the seller by reason of escalator clauses based on price indices or changes in the price received by the purchaser upon resale, or the payment, or offer of payment, of higher prices by the purchaser in the same or other producing areas or to other sellers. Such clauses, says the FPC, are not in the public interest.

★ ★ ★

Serious oil industry division is seen as a result of a series of posters being distributed by the National Oil Marketers Association. The posters attack the "big oil monopolies" who "overbuild the service station markets, dominate illegal and unfair practices of market losses in their own operations."

What Makes a Man Work?

In great demand by readers are reprints of the article "What Makes a Man Work?" by Dr. A. Q. Sartain, published in the March 1956 issue of The Petroleum Engineer.

The article is a penetrating answer to a key question asked by management from top to lower levels: What produces the all-important morale that inspires good work? It has received high praise from management in petroleum and other industries. Scores of requests have been received and a reorder of reprints has been filled.

For those interested in obtaining copies the price is:

1 to 10 copies ..... 25 cents each
10 to 50 copies ..... 15 cents each
50 or more copies ..... 10 cents each

The Petroleum Engineer
Box 1589
Dallas 21, Texas

Higher mill prices for various grades of pig iron have been announced by several manufacturers. Expected to affect the pipe costs, the price was advanced about $1.50 per gross ton, effective April 1.

★ ★ ★

Retail gasoline price reductions are being suggested by Atlantic Refining Company in the Philadelphia area "following analyses of competitive situations." The new prices would decrease the prices 1 cent from 27 to 26 cents. The posted tank wagon price has been cut from 22½ to 21½ cents per gallon, effective April 19.

★ ★ ★

Oil pipe lines to the East Coast in the future should go without government help, an Office of Defense Mobilization staff study has recommended. New facilities, the report states, are not now needed from a defense standpoint. ODM Mobilizer Flemming has notified Texas Eastern Transmission, American Pipeline Corporation and other interested parties, who are seeking to build lines to the Ohio-Pittsburgh area with government aid. The ODM study used an Interior Department survey to point out that needed oil could be transported "with relatively minor change-overs of present facilities."

★ ★ ★

Texas Senator Lyndon Johnson has now assumed chairmanship of an appropriations subcommittee which will pass on funds for the State and Justice departments—including money allotment for the investigation of the Interstate Compact Commission. In this spot, Johnson will be able to ask "questions as to the need for further study of the compact, and could possibly suggest curtailment of the probe. Johnson gave up his seat on the finance committee, which handles depletion allowance and other tax matters, for the job, made vacant recently by the death of Senator Harley Kilgore of West Virginia.

★ ★ ★

Refinery strikes in Indiana have brought about crude oil curtailments in Oklahoma, that may have had serious bearing on state allowable cutting. Anderson-Prichard, Rock Island Refining, Cities Service and Ben Franklin have cut purchasing in Oklahoma, and several natural gas purchasers have announced shutoffs for the summer. Oklahoma's per well oil allowable has been cut back 15 per cent for May, for an estimated run of 580,000 bbl of oil daily.

ENGINEER CONTROLS STARTING, OPERATING AND SHUTDOWN OF ALLISON-POWERED PUMPING UNIT AT DOWELL-DEVELOPED REMOTE PANEL

Two new developments for fracturing, acidizing

ALLISON AIRCRAFT ENGINE — After establishing an exceptional record in fighter planes, Allison power has been put to work by Dowell for fracturing and acidizing.

The rugged, 1500-h.p. engine has low weight per horsepower. This allows Dowell to mount it and the specially designed DR pump on one truck for mobility and economy.

REMOTE CONTROL UNIT — Makes possible control of the Allison pumper from any distance up to 125 feet. Instruments on the unit show operating conditions of the engine, torque converter and pump as well as treating pressures and volumes.

Maximum treating pressures and volumes cannot be exceeded. Preset automatic controls shut down the entire unit when safe limits have been reached. Here is protection for your men and equipment never before possible.

For more information or service, call any of the 165 Dowell offices in the United States and Canada; in Venezuela, contact United Oilwell Service. Or write to Dowell Incorporated, Tulsa 1, Oklahoma, Dept. E-12.

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This *exclusive* OIC lubricated plug valve design not only prevents shank leaks, it also helps retain gland adjustment longer. That's why OIC plug valves rate high with maintenance men. For details write for the new OIC bulletin, Form No. 1003-R.

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Meetings

May 1-3—**Petroleum Industry Electrical Association and Electrical Suppliers Association,** annual conference and exhibits, Statler Hilton Hotel, Dallas, Texas.

May 4—**Annual Conference for Engineers,** Ohio State University, Ohio Union, Columbus, Ohio.

May 6-9—**Liquefied Petroleum Gas Association,** convention and show, Conrad Hilton Hotel, Chicago, Illinois.

May 6-9—**American Institute of Chemical Engineers,** Roosevelt Hotel, New Orleans, Louisiana.

May 9-11—**American Association of Oilwell Drilling Contractors,** Conference for Drilling Executives, Baker Hotel, Dallas, Texas.

May 10-11—**American Gas Association** gas supply, transmission and storage conference, Conrad Hilton Hotel, Chicago, Illinois.

May 10-11—**American Petroleum Institute,** Division of Production, Pacific Coast district, Statler Hotel, Los Angeles, California.

May 13-15—**Empire State Petroleum Association,** Statler Hotel, Buffalo, New York.

May 13-15—**Pennsylvania Petroleum Association,** Bedford Springs Hotel, Bedford, Pennsylvania.

May 14-15—**American Institute of Mining and Metallurgical Engineers,** Formation fracturing Symposium, Wichita, Kansas.

May 14-16—**American Petroleum Institute,** Pipe Line conference, Shamrock Hotel, Houston, Texas.

May 14-16—**Petroleum Electric Power Association,** 27th annual meeting, Driscoll Hotel, Corpus Christi, Texas.

May 14-17—**American Petroleum Institute,** Division of Refining, midyear meeting, Montreal, Canada.

May 17-18—**American Institute of Mining and Metallurgical Engineers,** joint meeting of Rocky Mountain Petroleum Sections, Gladstone Hotel, Casper, Wyoming.

May 20-22—**Tennessee Oil Men's Association,** Lookout Mountain Hotel, Chattanooga, Tennessee.

May 22-24—**Pennsylvania Gas Association,** Pocono Manor Inn, Pocono Manor, Pennsylvania.

May 24-25—**Natural Gas and Petroleum Association of Canada,** Sheraton Brock Hotel, Niagara Falls, Ontario, Canada.

May 30-June 1—**Short Course in Gas Technology,** annual, Texas College of Arts and Industries, Kingsville, Texas.

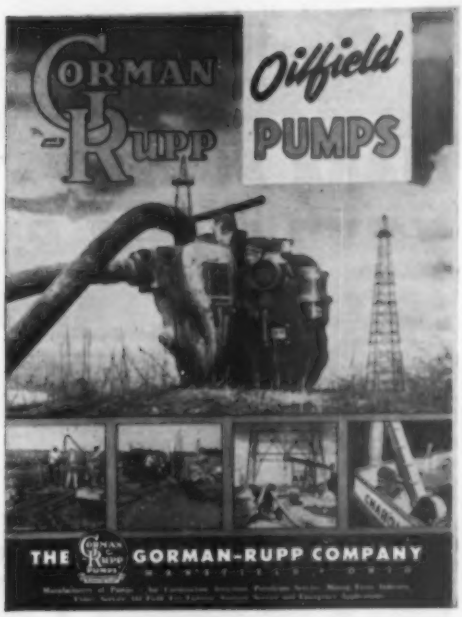
May 31-June 2—**Interstate Oil Compact Commission,** mid-year meeting, Statler Hilton Hotel, Dallas, Texas.

June 10-15—**American Petroleum Institute,** Division of Production, mid-year standardization conference, Brown Palace and Cosmopolitan Hotels, Denver, Colorado.

June 11-13—**Appalachian Underground Corrosion Short Course,** first annual meeting, School of Mines of West Virginia University, Morgantown, West Virginia.

June 13—**Pennsylvania Grade Crude Oil Association,** 33rd annual meeting, Pennhills Club, Bradford, Pennsylvania.

June 17-22—**American Society for Testing Materials,** Chalfonte-Haddon Hall, Atlantic City, New Jersey.



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If you specify or purchase oilfield equipment, you will want to have on file this recently published catalog. Featuring all the many models of Gorman-Rupp Pumps useful to this important field, it contains specifications, performance data, cutaway views and application information. A copy will be sent you on receipt of the coupon below, by our Mid-Continent & Gulf Coast Oilfield Representative.

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June 17-22—**Creative Engineering Seminar,** The Pennsylvania State University, University Park, Pennsylvania.

June 17-22—**American Society for Testing Materials,** Pacific Coast meeting, Hotel Statler, Los Angeles, California.

June 21-22—**Western Petroleum Refiners Association,** regional technical-industrial relations meeting, Broadview Hotel, Wichita, Kansas.

June 25-29—**The American Society for Engineering Education,** annual meeting, Iowa State College, Ames, Iowa.

June 26-29—**Canadian Gas Association,** Manoir Richelieu, Murray Bay, Quebec, Canada.

June 28-30—**Rocky Mountain Oil and Gas Association,** mid-year meeting, Utah Hotel, Salt Lake City, Utah.

Aug. 20-Sept. 7—**Short Course in Colloidal Phenomena in the Petroleum Sciences,** Louisiana State University, Baton Rouge, Louisiana.

Sept. 9-12—**American Institute of Chemical Engineers,** William Penn Hotel, Pittsburgh, Pennsylvania.

Sept. 10-14—**International Congress on Catalysts,** Bellevue-Stratford Hotel, Philadelphia, Pennsylvania.

Sept. 11-13—**Pacific Coast Gas Association,** annual meeting, Coronado, California.

Sept. 12-14—**National Petroleum Association,** annual meeting. Traymore Hotel, Atlantic City, New Jersey.

Sept. 12-14. **Third Annual Electrical Conference of the Petroleum Industry,** sponsored by American Institute of Electrical Engineers and Kansas City Section of AIEE, Kansas City, Missouri.

Sept. 16-22—**American Society for Testing Materials,** Pacific Coast meeting, Hotel Statler, Los Angeles, California.

Sept. 17-21—**Instrument Society of America,** annual, Instrument-Automation Conference and Exhibit (International), New York Coliseum, New York City.

Sept. 20-21—**Mid-Continent Oil and Gas Association,** La.-Ark. division membership meeting, Roosevelt Hotel, New Orleans, Louisiana.

Sept. 20-21—**Western Petroleum Refiners Association,** regional technical-industrial relations meeting, Hotel Henning, Casper, Wyoming.

Oct. 1-5—**American Institute of Electrical Engineers,** Morrison Hotel, Chicago, Illinois.

Oct. 2-3—**Texas Mid-Continent Oil & Gas Association,** 37th annual meeting, Rice Hotel, Houston, Texas.

Oct. 14-17—**American Institute of Mining and Metallurgical Engineers,** Petroleum branch, fall meeting, Biltmore Hotel, Los Angeles, California.

Oct. 18-19—**Western Petroleum Refiners Association,** regional technical-industrial relations meeting. Rufus Garrett Hotel, El Dorado, Arkansas.

Oct. 25-26—**Independent Petroleum Association of America,** annual membership, Mayo Hotel, Tulsa, Oklahoma.

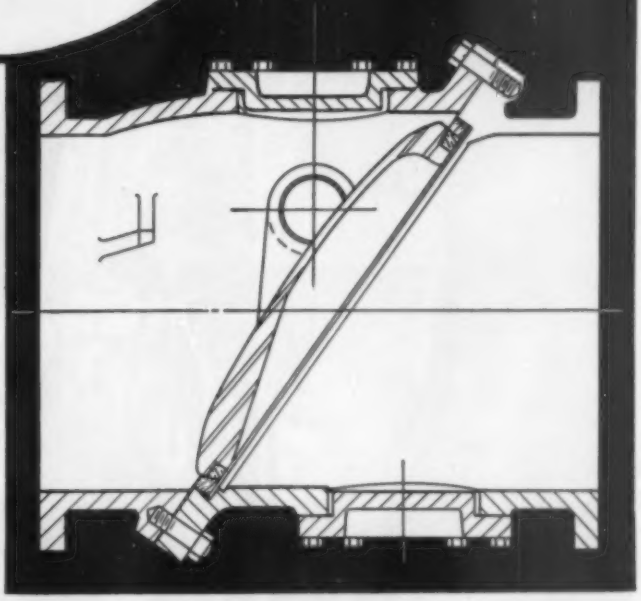
Nov. 12-15—**American Petroleum Institute,** 36th annual meeting, Conrad Hilton Hotel and Palmer House, Chicago, Illinois.

Nov. 19-20—**North Texas Secondary Recovery Symposium,** Petroleum branch, AIME, Municipal Auditorium, Wichita Falls, Texas.

Dec. 9-12—**American Institute of Chemical Engineers,** annual meeting, Statler Hotel, Boston, Massachusetts.

CHAPMAN TILTING DISC CHECK VALVE

the Valve with the Right Idea!



Here is a cross section of top check valve performance at lowest cost. It's the idea in back of Chapman's Tilting Disc Check Valve . . . the valve that's designed to go with the flow.

When the flow is on, specially designed "airfoil" disc balances perfectly in open position. Fluid holds it tightly against stops. There's no vibration . . . no flutter. It's quiet. And note the design. Ample room is allowed around disc to assure low flow resistance.

When the flow is reversed, disc drops surely, quietly, *tightly* on special beveled seat. There's no banging, no slamming, no scraping or wearing of disc and seat faces, no damage to piping joints or the valve itself. It's as simple as that. It's as *sound* as that. It has the right idea.

Complete information on these rugged, quiet, long life check valves is highlighted in our Catalog 30-A. Whether you want iron or steel construction . . . whether you handle fluids or gases under a wide range of pressures . . . this catalog gives you all the facts. Send for your up-to-date copy, today.

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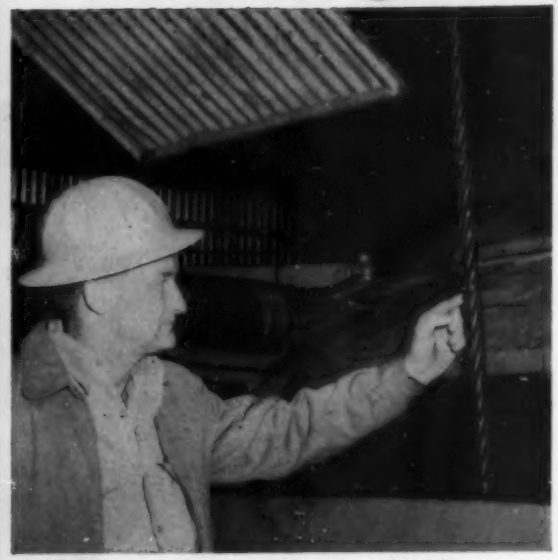
INDIAN ORCHARD, MASS.

"We got

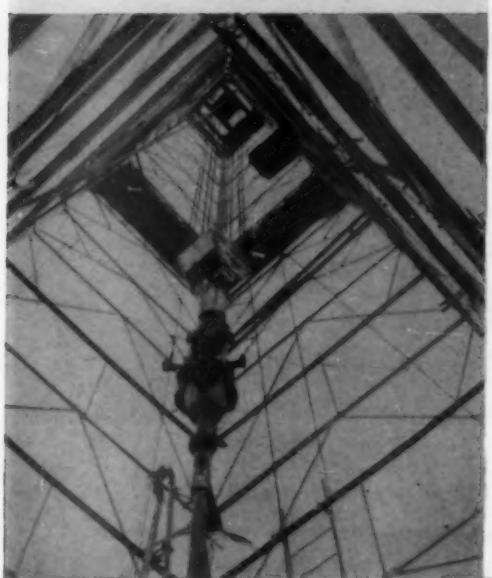


Bill Williams, tool pusher, says "We've used a number of different drilling lines but we've never found one better than Tiger Brand for low ton-mile costs."
Barge Rig of C. A. Norton Drilling Company on Lake Salvador, St. Charles Parish, Louisiana.

32,824 ton miles with one Tiger Brand Rope"

"According to ton-mile records, we've never had a better rope than Tiger Brand,"

says Mr. W. C. Williams, Tool Pusher for Norton Drilling Company, New Orleans, La.



The Norton Drilling Company Rig No. 5 is an inland marine barge of the split-hull type designed for shallow water. It was drilling about 30 miles south of New Orleans when these photographs were taken.

The rig was equipped with a 2,500-foot Tiger Brand 1¼", 6 x 19, IWRC drilling line. This had been in service about eight months drilling 68,277 feet of hole for a total of 32,824 ton miles. The rope had been cut back at the drum regularly in the course of service . . . a practice which paid off in longer rope life and lower costs.

Norton Drilling Company keeps accurate ton-mile records which they consider to be the best method for judging the life of wire rope. That's why they used Tiger Brand on this important barge rig where any shut-downs would be extremely expensive.

Why not prove it to yourself? Send the coupon for one of our free Ton-Mile Calculators. Then rig up with Tiger Brand and check its performance *on your own rig*. We're sure you'll be back for more Tiger Brand Line.

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One Tiger Brand Wire Rope drilled five wells averaging about 10,000 feet each and there was still plenty of service left in it.

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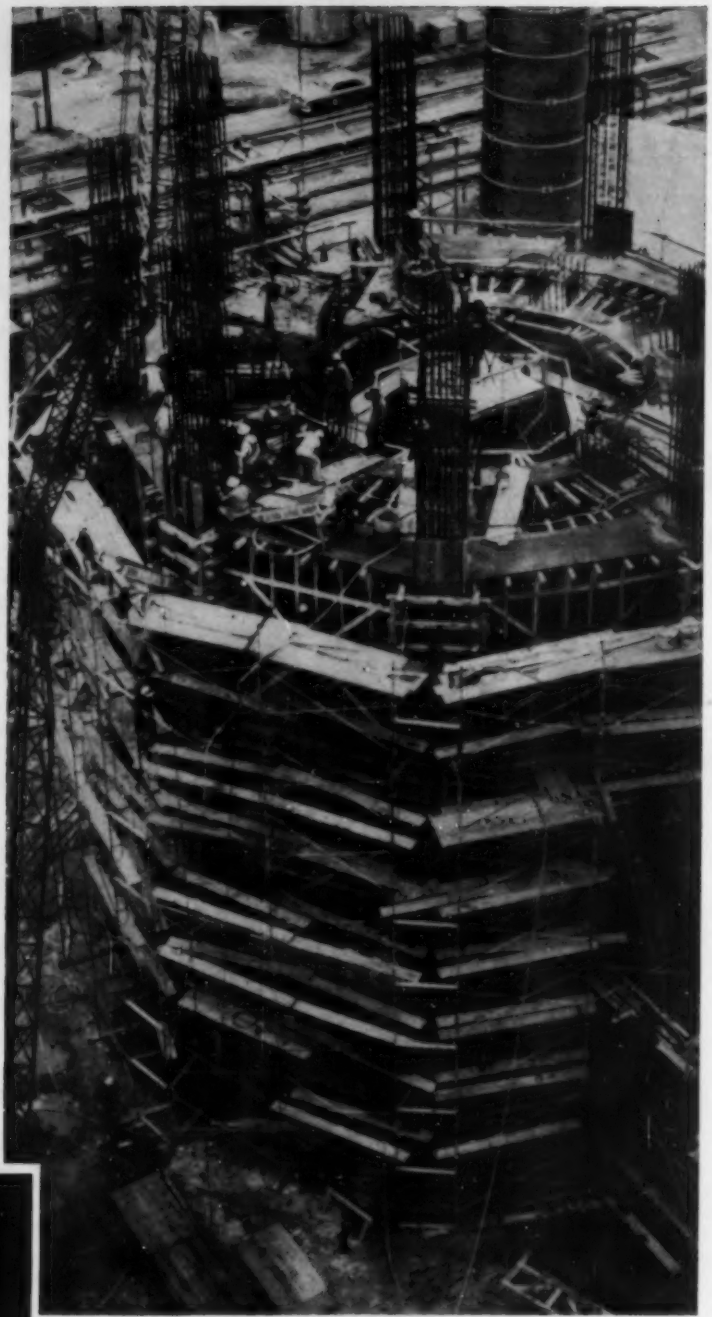
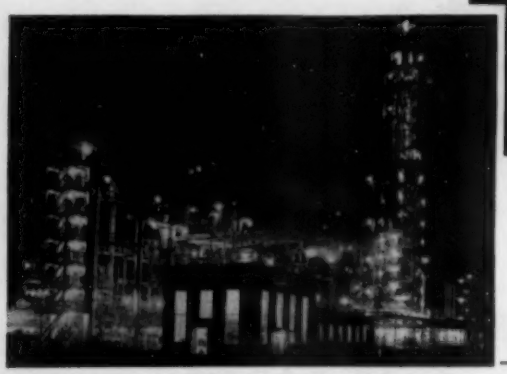
World's Largest Airlift TCC Unit is now being built at Beaumont, Texas. This 35,000-Barrels-A-Day Unit is one of 50 Airlift TCCs built or building all over the world.



Part of New York's skyline—TCC Unit at Socony Mobil's Brooklyn refinery.



West Germany—TCC Unit at Heide Refinery of Deutsche Erdol-A.G.

TCCs are operating on all six continents—from Finland to Formosa, from Australia to Turkey

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TYPE 657A

Double port globe body for conventional service. Also supplied single port where tight closure required. Normally supplied in iron or steel in sizes ½" thru 12".

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Small and compact bronze control valve for relatively light service. Available in screwed sizes ½", thru 2".

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Fisher operator on Saunders patented valve is widely used on "hard to handle" fluids which are viscous and/or corrosive. Available in wide variety of materials in sizes ½" thru 6".

Special design bodies for process services

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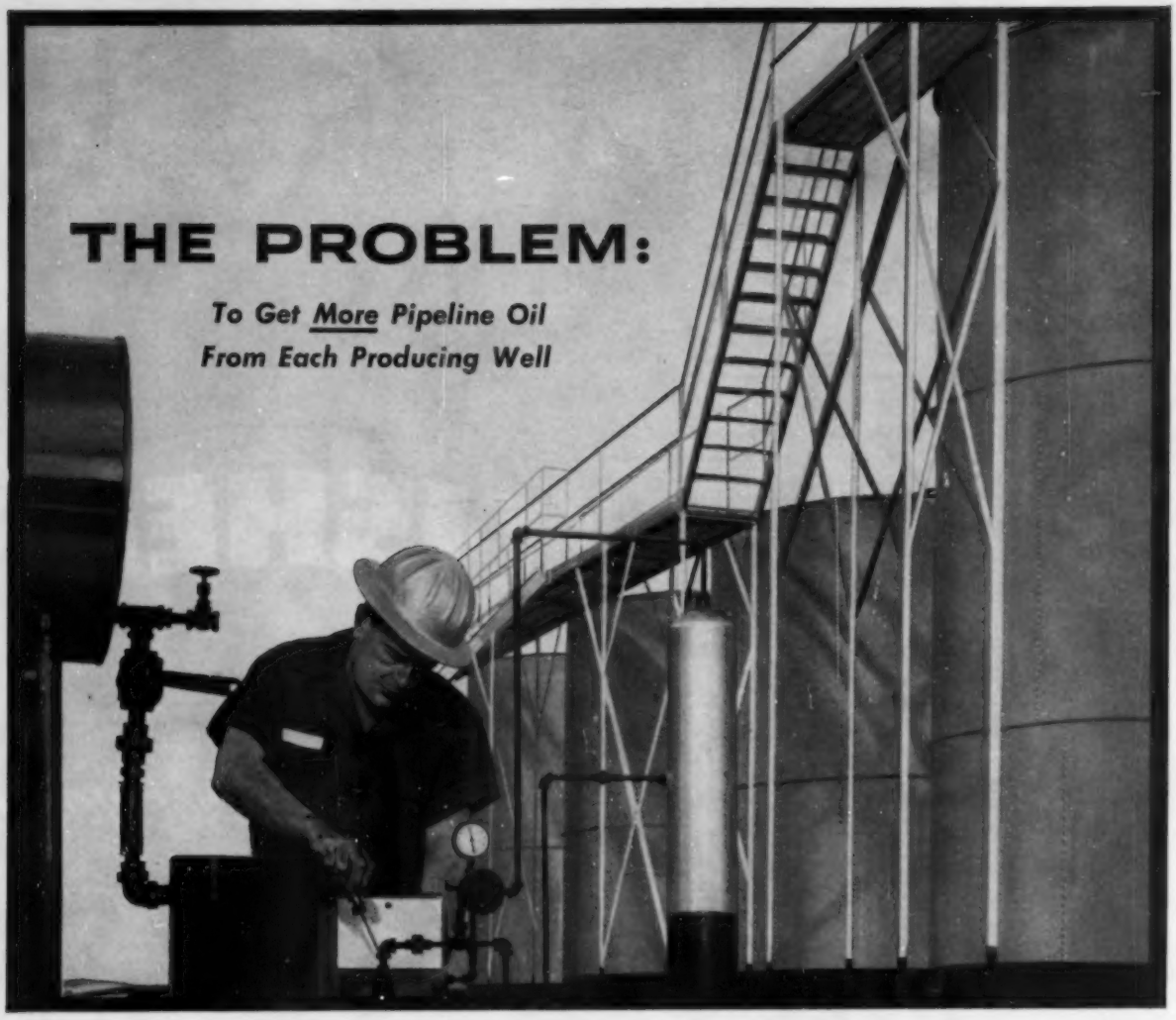

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Companies that have used *Breaxit* to break crude oil emulsions report important savings through lowered treating cost and increased recovery.

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Pumping Progress Report

FOR PETROLEUM ENGINEERS

An advertisement prepared by the Aldrich Pump Co., Member of Hydraulic Institute, U.S.A.

SPACE, in many pump installations, is a major problem. Another is the necessity for special foundations. When new installations are considered, these factors may dictate more elaborate construction than should be necessary. And for replacement or modifications of existing systems, they may require expensive piping and equipment changes.

COMPACTNESS OF DESIGN, while often desirable, is not necessarily the answer. Simplicity of design — as in the case of ALDRICH Direct Flow Pumps — may be a better solution.

SIMPLICITY OF DESIGN brought about the first inverted Triplex and Quintuplex Pumps and ultimately Septuplex and Nonuplex Pumps. This Aldrich design innovation brought to pump users many economies of space, maintenance and operation they had never known.

INVERTED PUMP DESIGN permits the use of less expensive foundations. With the crankshaft located near the floor there is no need for expensive foundation work to raise the driver or lower the pump. Then, too, inverted pumps require fewer square feet of floor space than conventional pumps.

MAINTENANCE COSTS ARE REDUCED. Fluid-end, where most work is done, is at chest level. Bearing replacements are made without removing heavy crankshafts or connecting rods. Crossheads on all Direct Flow Pumps can be worked on or removed from pump without disturbing fluid-end.

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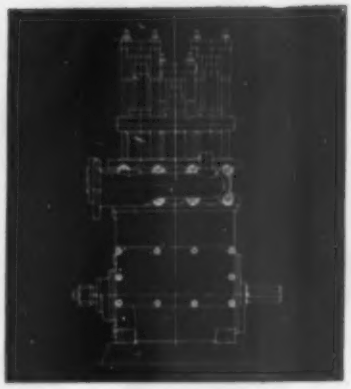


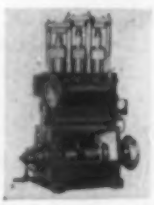
Aldrich inverted vertical pump design

...for your tough pumping problems specify ALDRICH

The entire line of Aldrich *Direct* Flow Pumps feature two outstanding design innovations—inverted vertical design and sectionalized fluid-ends. These two features have helped make Aldrich the organization hydraulic engineers turn to when they face tough pumping problems. If you have a pumping problem, turn it over to the men who have never turned down a challenge.

CHECK THESE ADVANTAGES OF INVERTED PUMP DESIGN:

Smaller Foundations
Simpler connection with prime mover
Less floor space required
Reduced maintenance costs



Write today for Data Sheets describing the Direct Flow Pump Series.

THE ALDRICH PUMP COMPANY

Originators of the Direct Flow Pump
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Pick YOUR Number –Win New Friends For Your Business!

Here is a simple way to make new friends for your business—and at the same time perform a real service for your industry.

You may ask "does my industry need help?" The answer is *yes*. For today it is urgent that the public appreciate more thoroughly the job oil men do. People must continue to feel the oil industry can best serve *them* by remaining privately managed, fully competitive, and free from excessive governmental control.

You can help in this vital public information program by joining your local Oil Industry Information Committee—made up of oil men from your community. Right now, 33,299 oil men like yourself are active. Aided by the OIIC District Office, your group can provide films, speakers and demonstrations for civic, social and church needs—in addition to classroom materials for high schools.

Joining in this effort will mean real help for your industry. But *you* will also profit. You'll enjoy the great personal pleasure of working with other members of your community. It will mean winning many new friends for yourself—and for your business as well.

So pick *your* number on the map above—and get in touch with the OIIC District Office in your area today! Why not do it *now* while you have the address handy.

AMERICAN PETROLEUM INSTITUTE
50 West 50th Street, New York 20, New York

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   Boston 16, Massachusetts
2. *New York, New Jersey*
   1270 Sixth Avenue, Room 1913
   New York 20, New York
3. *Del., Pa., Md., Va., W. Va., Dist. of Columbia*
   1322 Broad-Locust Building
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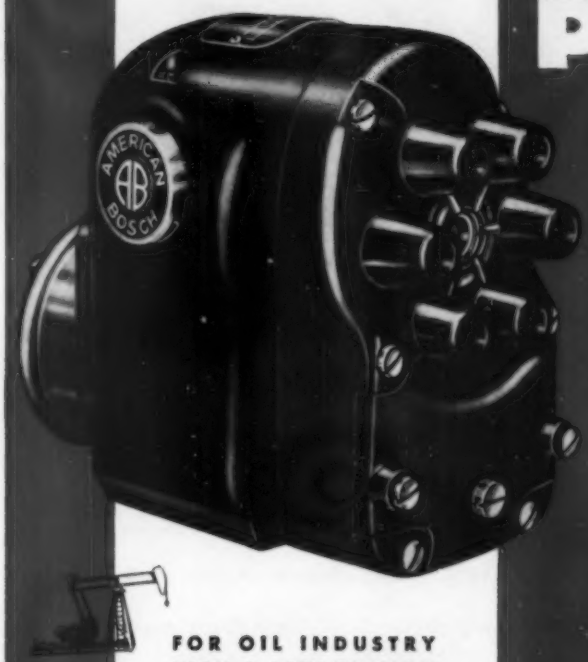

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Fast, powerful — that's the power-packed story of American Bosch Magnetos — today's finest ignition units for oil industry engines. Many advanced features give these famous Magnetos greater power for split-second starting, PLUS the built-in stamina that assures years of constant, trouble-free operation in Drilling, Producing, Pipe Line and Refinery service. That's why they're so widely used as original equipment by so many leading engine builders.

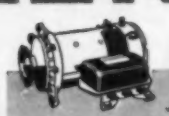
For your every replacement need, there's an American Bosch Magneto precisely engineered for maximum efficiency at all engine operating speeds and loads. Moreover, American Bosch can serve you well with all the advantages of one of the world's largest and most efficient Service organizations. There's an AB Service Agency near you. Write today for application data on your high or low tension ignition engines. American Bosch, Springfield 7, Mass. A Division of American Bosch Arma Corporation.

FOR OIL INDUSTRY HIGH & LOW TENSION SPARK IGNITED ENGINES

In drilling rigs, oil pumping stations, pipeline operations and gas-engine driven compressors . . . wherever they are in service in oil industry engines, American Bosch Magnetos and Pulse Generators deliver consistently dependable performance in month-after-month of continuous operation.

AMERICAN BOSCH

Automotive and Aviation Magnetos



Generators and Regulators

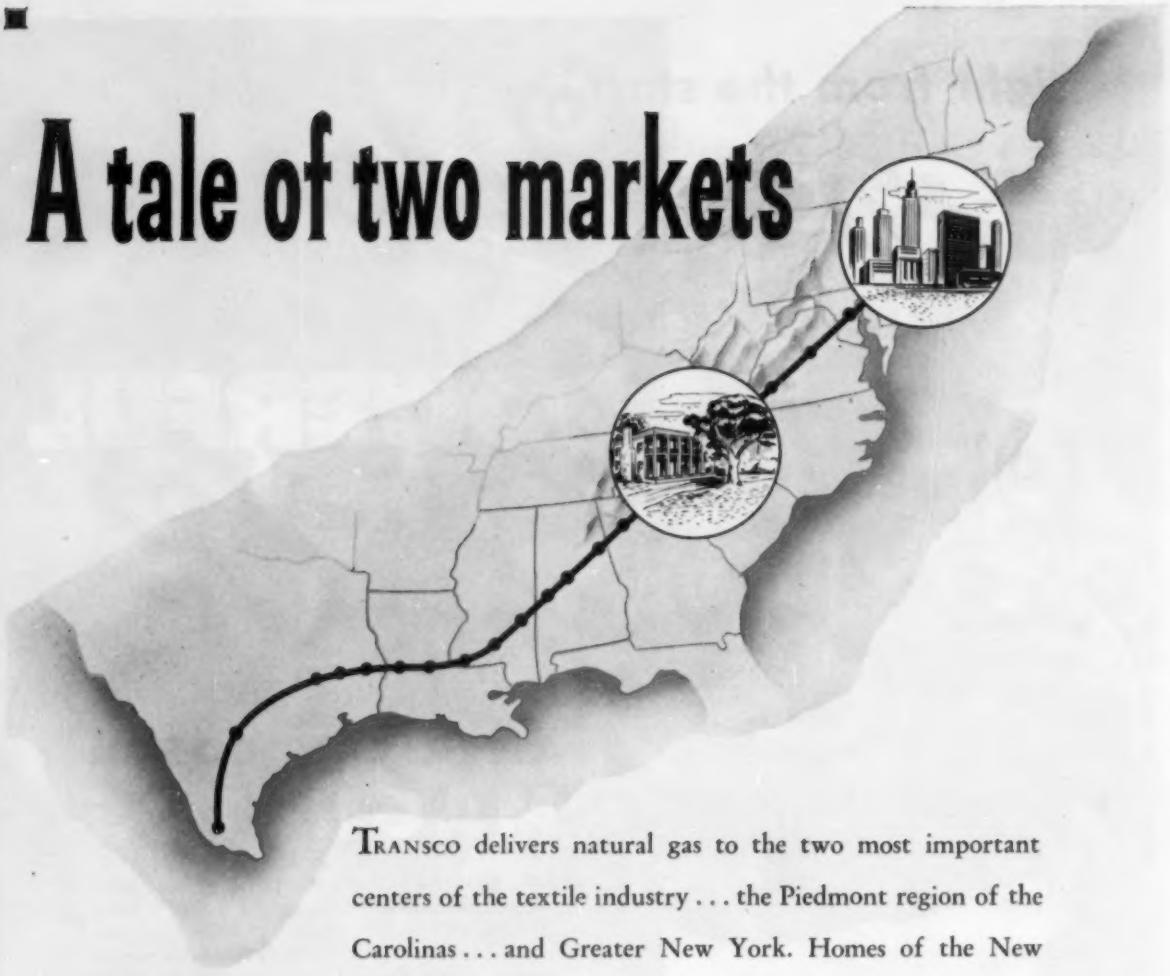
Components for Aircraft Engines

Small Electric Motors

Electric Windshield Wipers

Diesel Fuel Injection Equipment

A tale of two markets



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TRANSCONTINENTAL GAS PIPE LINE CORPORATION

TRANSCONTINENTAL GAS PIPE LINE CORPORATION

200-TON RIG SKIDDED 1/2 MILE IN 90 MINUTES —WITH HELP OF NEW D7

Three sure-footed CAT* track-type Tractors moved a 400,000-lb. rig ½ mile through deep Texas sand in 90 minutes for Rumbaugh, Inc., Odessa, Tex. Equipment skidded included a Lee C. Moore 129-foot derrick, substructure, drawworks and engines.

To do the job quickly in the deep sand, Mr. Rumbaugh teamed a powerful new D7 (Series C) with two of his D8s. All were equipped with Hyster worm drive winches. Mr. Rumbaugh and his brother own two D8s, nine D7s and nine D6s.

The new D7 was designed to work fast and efficiently in the rough going of the oil patches. For rig-moving, there's plenty of power in its new 128-HP engine—with up to 28,700-lb. drawbar pull.

When drilling is completed and equipment must be moved out, you'll find new economy and ease of operation in Caterpillar's exclusive oil clutch which rarely needs adjustment. No matter how rugged the footing, you'll find longer wear in the D7 track shoes now hardened by a "water-quench" process. And your operators will appreciate its finger-tip steering and new starting engine.

Stop by your nearby Caterpillar Dealer soon and inspect the new, improved D7. Or better still, call him and ask for a demonstration. See what this powerful new tractor will do on your job.

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

CATERPILLAR*

*Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

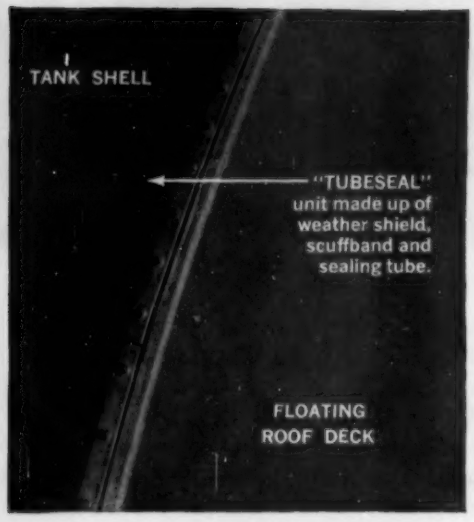
NAME THE DATE... YOUR DEALER WILL DEMONSTRATE

RESULTS CONVINCED

In 1954 the "X" Company* bought

TO DATE THEY HAVE PURCHASED 17 ADDITIONAL TUBESEALS

...on the basis of proved performance!



Looking down on Hammond Tubeseal in position on Floating Roof tank. Neoprene weather shield and ribbed scuffband protect oil-filled sealing tube, which is in continuous contact with product, thereby eliminating vapor space.

*** One of the nation's largest oil companies. Name on request.**

† Patented

UNUSUAL? No, merely typical of the many new users who are adding fresh chapters to Tubeseal's exciting "success story." And no wonder! Tubeseal is the **only** floating roof that eliminates vapor space while providing a **positive** seat at all points between the roof, shell and product. No vapor-air mixture can lurk above the product—because there is no space for vapor to form.

Think of the advantages this offers! Regardless of the product you are storing—vapor losses simply can't occur. And with products of intermediate volatility, such as jet fuels, the dangers of exploding vapors and rim fires are practically non-existent.

NO CORROSION
NO MECHANICAL MAINTENANCE
CLIMATE PROOF

In contrast to conventional metal shoe seals, where rusting and corrosion shorten seal life and create contamination, the Tubeseal is completely non-corroding. Nor will it scuff, abrade or injure the interior tank surface. And because it has no moving parts, there is no mechanical maintenance required.

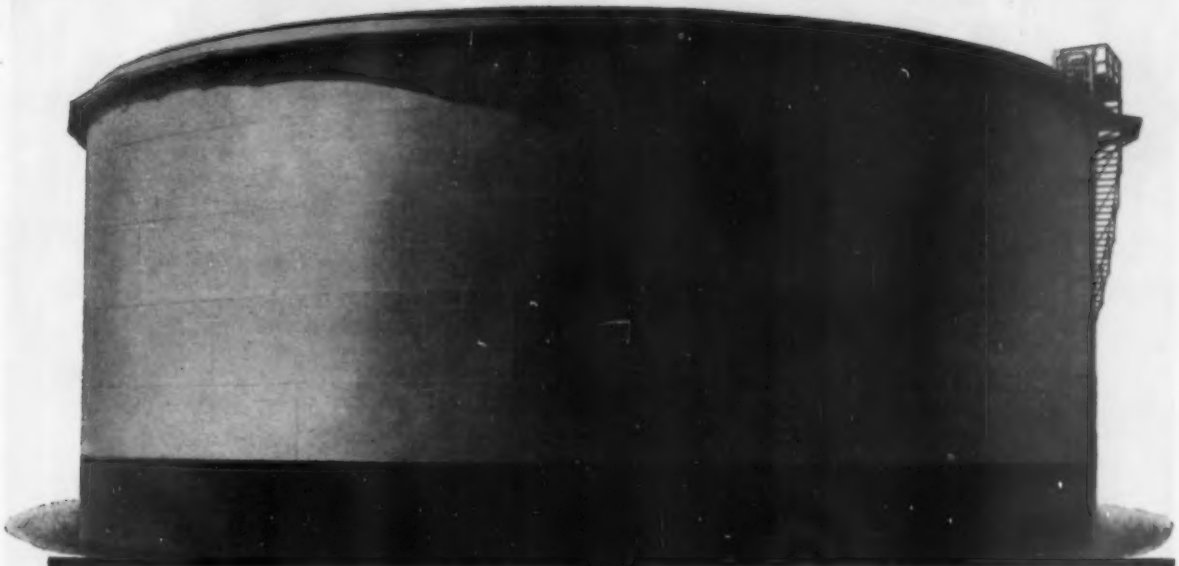
Tubeseal Floating Roofs can be efficiently used on all types of new and existing tanks—even those of riveted construction where metal shoe seals are particularly inadequate. The liquid-filled tube quickly adjusts to irregular shapes, overcoming any tank out-of-roundness.

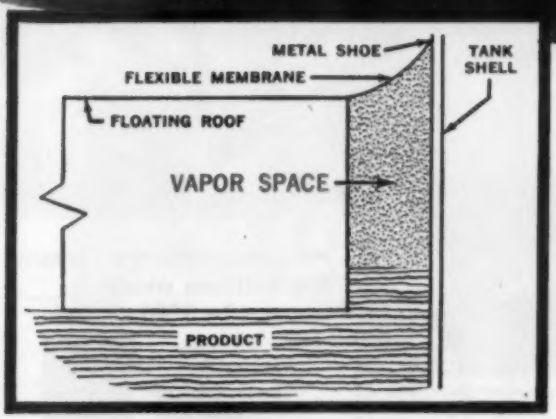
Whether you are storing gasolines, jet fuels, sour crudes, light crudes, alcohol, naphthas, polyesters or similar products, Tubeseal is **the most efficient and positive seal known.**

BUILT TO YOUR SPECIFICATIONS...GUARANTEED TO YOUR SATISFACTION!

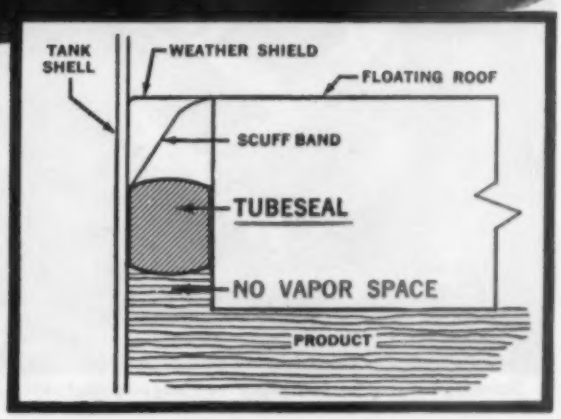
THIS MAJOR REFINER*...

ONE Tubeseal† Floating Roof Tank





Conventional floating roof tank has space between flexible membrane where air-vapor mixtures form. Because metal shoe and membrane cannot be absolutely gas tight, vapor is constantly escaping. This condition causes excessive corrosion, may also result in fire from lightning or other source.



HAMMOND TUBESEAL FLOATING ROOF entirely eliminates every space where air-vapor mixtures can form. **Hammond Tubeseal** completely fills space between product surface and roof seal, so that corrosion is stopped (even for sour crudes), and vapors cannot form—hence cannot ignite or be lost.

HAMMOND TUBESEAL COSTS NO MORE IN THE FIRST PLACE

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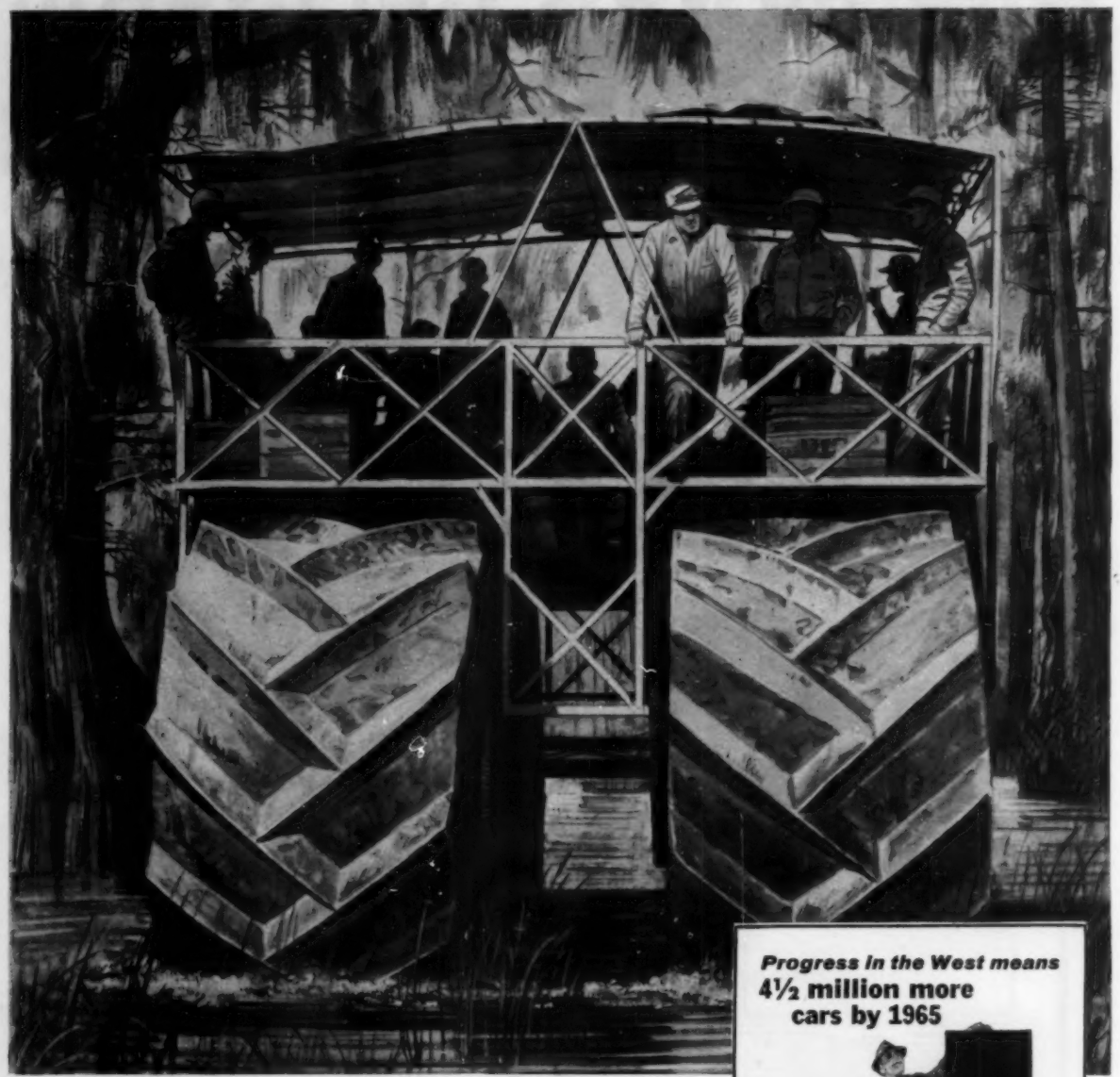
Standard is exploring 40 countries* to keep America's oil reserves the highest in history



Specially designed "swamp buggy" carrying oil geologists into a Louisiana wilderness

SWAMP BUGGIES, snowmobiles — even helicopters — are used by Standard's geologists, who seek petroleum throughout the free world and in 33 U.S. states. Our search never ends. Last year, in the Western Hemisphere alone, Standard invested $134 million in exploration, drilled 107 test wells. We added nearly three times as much oil to reserves as we brought from the ground. But U.S. consumption rises steadily. It's now over 9 million barrels *per day* and expected to increase ⅓ within 10 years. So in 1956 we'll again invest many millions in exploration, drill scores of new wells—seeking the oil you'll use tomorrow.

** Includes operations of affiliated companies in the Eastern Hemisphere*

STANDARD OIL COMPANY OF CALIFORNIA
puts petroleum progress to work for you

Let's get technical about WALWORTH LUBRICATED PLUG VALVES for pipeline service

Combination button-head lubricant fitting and lubricant screw is provided at no extra cost. Valves can be lubricated with a Walworth High Pressure Lubricant Gun without removing the screw . . . little chance of grit getting into the valve. (Always use Walworth Lubricants with Walworth Lubricated Plug Valves.)

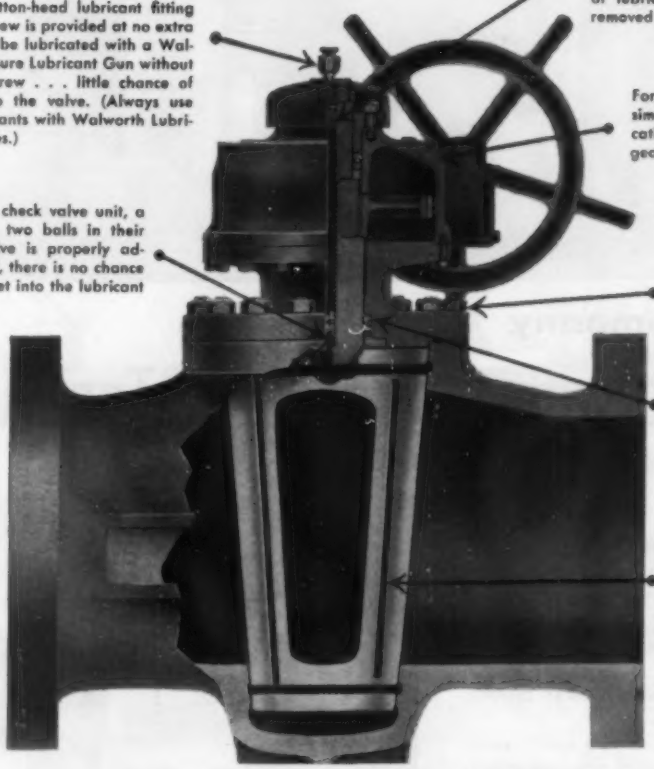
An added safety feature in the form of a groove cut part way up side of the lubricant-fitting screw allows the operator to observe any tendency of lubricant to blow out before the screw is removed entirely.

For buried pipelines — yoke design permits simple attachment of handwheel and lubrication extensions without modifying the gearcase.

In the stainless steel check valve unit, a transverse pin holds two balls in their seats. When the valve is properly adjusted and lubricated, there is no chance for line pressure to get into the lubricant system.

Standard bolt threads, rather than fine threads, mean easy replacement of nuts and bolts from local stocks.

Two overlapping Teflon packing rings form an effective seal against possible leakage without "grabbing" the plug shank. Low breakout torque . . . plug turns easier. Packing serves only as a seal and is not used to hold the plug in its seat.



Lubricant grooves completely frame the port openings and encircle the plug at the top and bottom assuring a tight seal against leaks. Bottom circumferential groove is separate from, but connected with, the lubricant well.

Other Walworth Lubricated Plug Valves include Single Gland and Regular Gland types. Sizes to 30 inches. Pressures to 5000 psi. and for vacuum service.

Cutaway of a 24-inch Walworth Lubricated Plug Valve

Use pigs or scrapers?

Walworth Type 49 Cast Steel Gate Valves are designed on the through-port principle to permit passage of pigs and scrapers — may be installed without regard to flow direction. Sizes 2 to 30 inches inclusive. Ask for literature.

Without exception, a Walworth Ball Bearing Lubricated Plug Valve is easier to operate and maintain than any other type of rotary-action, sealed valve available today for pipeline service. Design features pointed out here show just a few advantages of Walworth Ball Bearing Lubricated Plug Valves.

Many pipeline companies throughout the world use Walworth valves for handling gas, crude, and finished products. Investigate the line of Walworth valves for your own needs. See your Walworth Distributor, or write for literature: Walworth Company, General Offices, 60 East 42nd Street, New York 17, N. Y.

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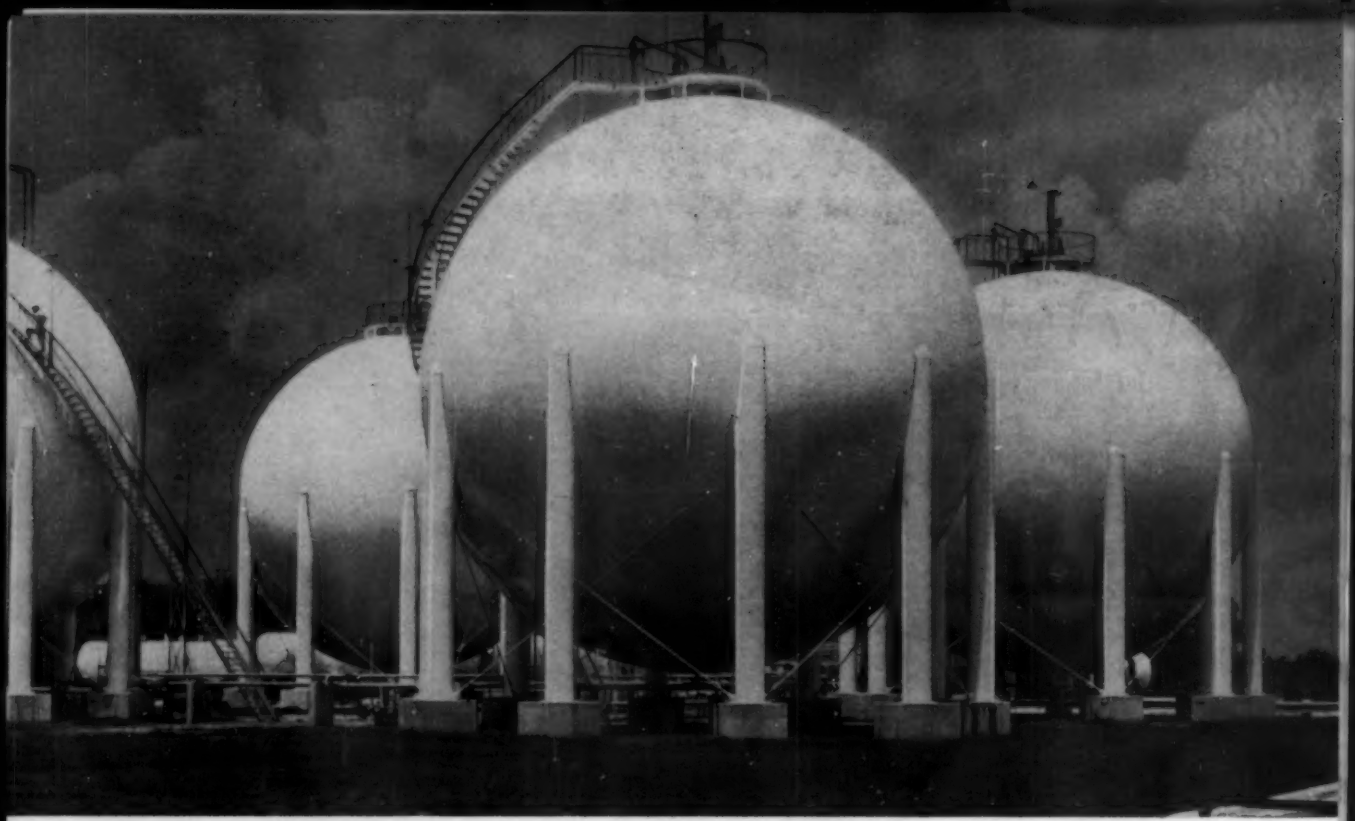
THROUGHOUT THE WORLD



How a major oil company

cuts costs 3 ways with new DULUX® Tank White

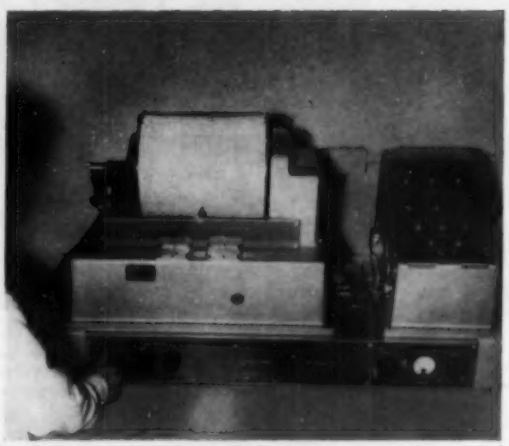
1. cuts evaporation losses
2. cuts application costs
3. cuts maintenance painting costs

Leading petroleum engineers agree that painting a tank white cuts evaporation losses to a minimum. The white pigment combination used in formulating DULUX Tank White provides controlled chalking to give maximum reflectance... maximum durability. Because DULUX reflects the sun's rays so well, tank interiors are cooler. Many users report evaporation losses cut by as much as 80%.

You begin cutting painting costs even as you apply new DULUX. Two coats of paint can be applied in one operation —the second coat sprayed at right angles to the first. This way, up to five mils of DULUX Tank White can be applied without sagging or wrinkling. Because of these fast-drying properties, scaffolding costs are reduced—insect, and dirt collection are minimized.

And the new higher-build DULUX lengthens painting cycles, reduces maintenance-painting costs. Repaint cycles can be extended by years. Tanks *stay* sparkling white because this rugged paint resists corrosion, industrial gases and rough weather.

For further information, consult your nearest Du Pont Sales representative or write: E. I. du Pont de Nemours & Co. (Inc.), Finishes Division, Wilmington 98, Delaware.



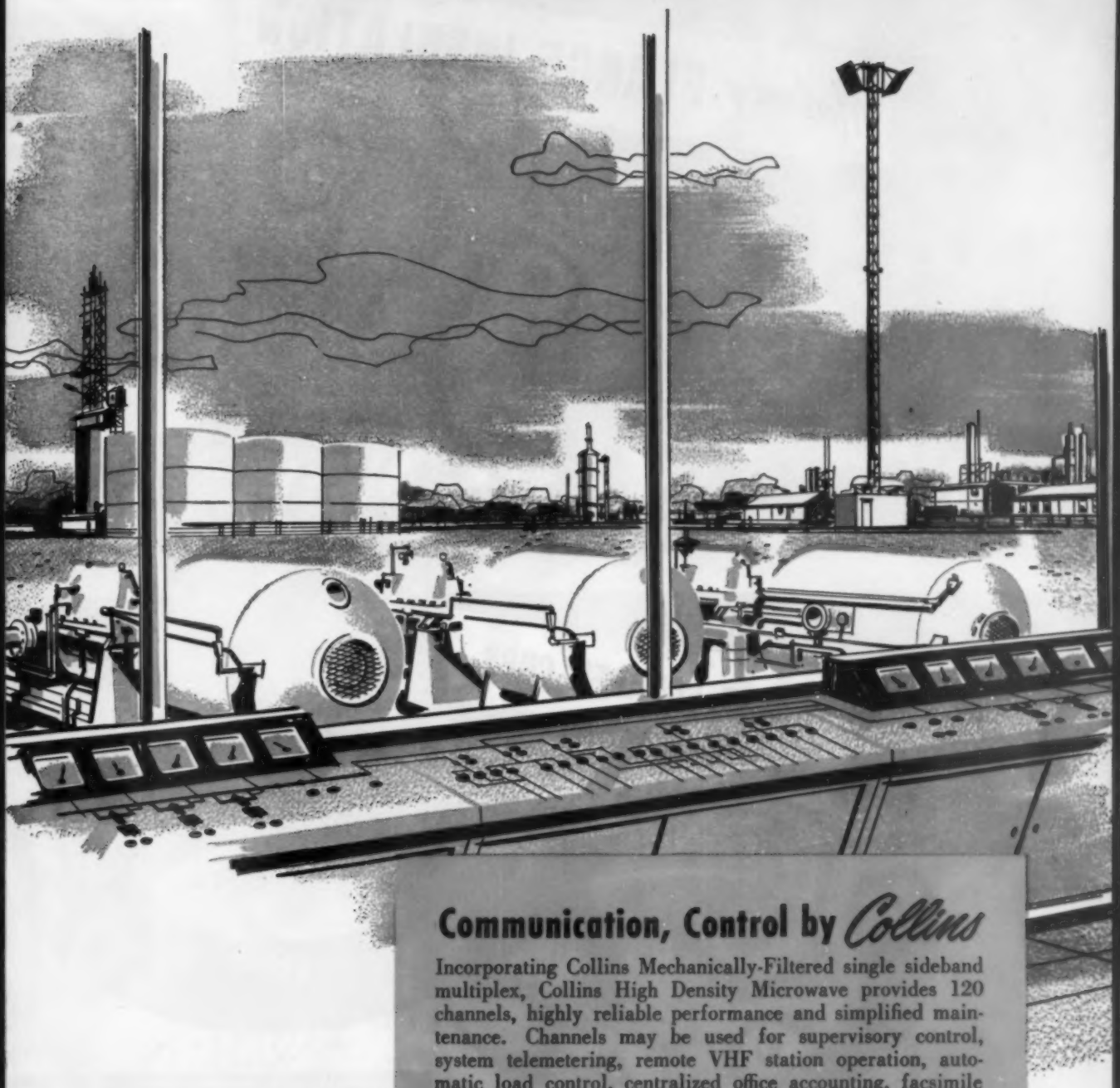
FINGERPRINTING A FINISH. Here a Du Pont chemist uses infrared transmission spectrometer to identify and control chemical characteristics of resins, oils and finishes. The pattern it gives is like a fingerprint and may be used to trace extent of reaction that occurs in the manufacture of a resin.

DU PONT
REG. U.S. PAT. OFF.

Petroleum Industry Finishes

Du Pont has the right finish for every petroleum-industry need

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY



Communication, Control by *Collins*

Incorporating Collins Mechanically-Filtered single sideband multiplex, Collins High Density Microwave provides 120 channels, highly reliable performance and simplified maintenance. Channels may be used for supervisory control, system telemetering, remote VHF station operation, automatic load control, centralized office accounting, facsimile and Teletype as well as private voice circuits.

Collins engineering services are available for evaluating, planning, and installing your integrated communication system

Collins LEADER IN COMMUNICATION

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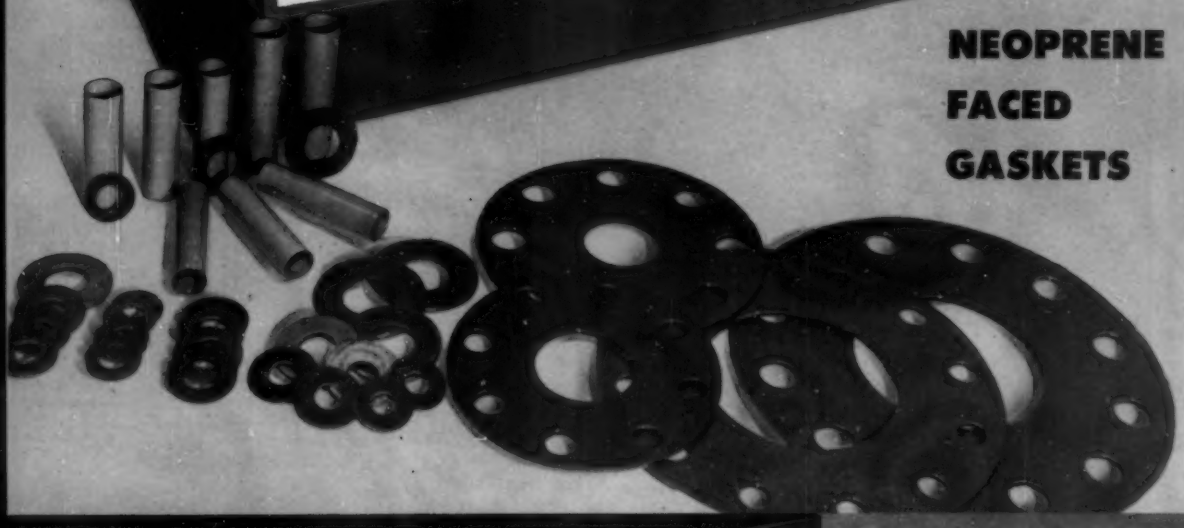
Maloney FLANGE INSULATION

NEOPRENE FACED GASKETS



Maloney PIPE LINE SCRAPER CUPS

"Something from the Irishman"

Maloney insulating sets, consisting of a central gasket, sleeves and washers, have become the standard in the cathodic protection field. They are designed to operate at the ASA rating of the flange at normal temperatures. Maloney also manufactures insulation out of special materials for higher temperatures. Complete sets are shipped in individually marked cartons.

Maloney scraper cups are ideal for service in out-of-round and varying weight pipe. The heavy lip wears evenly and gives longer effective life. Maloney scraper cups are manufactured from a selected Neoprene compound, have excellent abrasive qualities, proper flexibility and retain dimensional stability under all service conditions.

F. H. MALONEY *Company*

Houston, Texas

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H&L Teeth that really DIG
SHARP teeth mean more ditch
FORGED ALLOY STEEL means greater strength
added up means more profit
H&L TOOTH COMPANY
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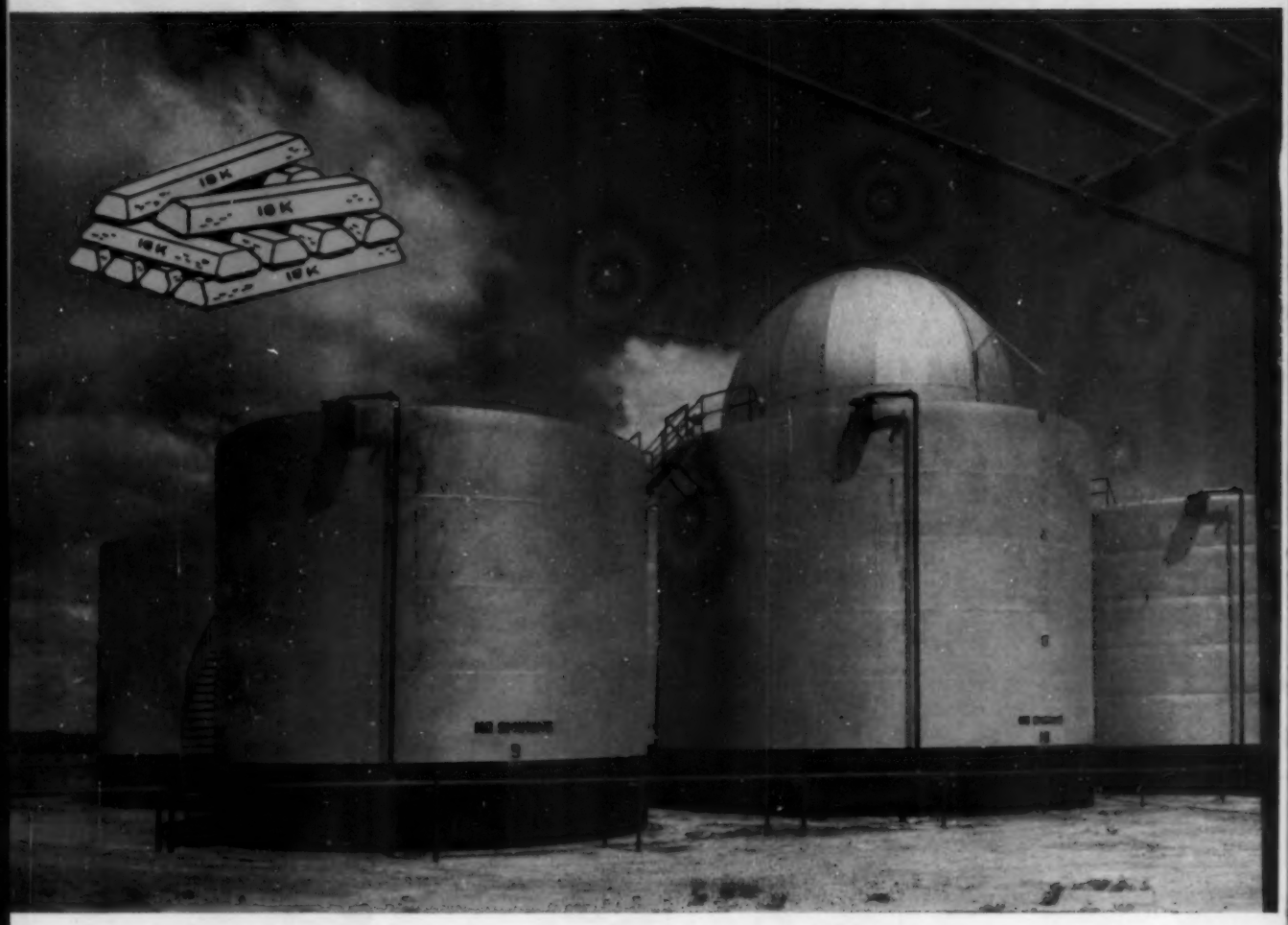
IF GOLD VAPORIZED...



like Volatile Hydrocarbons

● Would you just sit and watch it go? That's exactly what's happening every time one of your fixed-roof tanks, that store volatile hydrocarbons, vents vapor to the atmosphere. Profits are disappearing if you're just sitting and watching. A Hortondome® Roof, like the one above, acting as the central unit in a vapor conservation system and interconnected to fixed-roof tanks, will store displaced vapor from the tanks under a flexible hemispherical membrane inside the dome. When conditions causing the displacement are reversed, the vapor will return to the tanks . . . and return profits to you. Complete information on Hortondome Roofs may be obtained by writing our nearest office.

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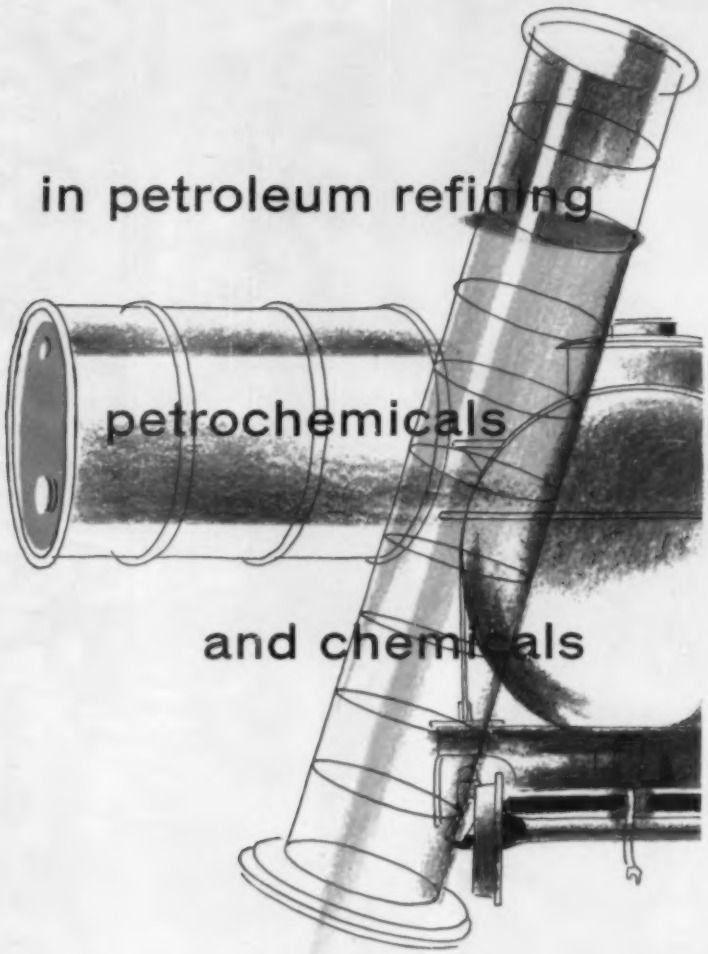

FLUOR OFFERS A COMPLETE ENGINEERING AND CONSTRUCTION SERVICE... *from project concept... to finished plant*

Neither raw-material source nor end-product classification limits Fluor's services to the process industries. A completely integrated organization and the broad experience of its staff enable Fluor to undertake projects of any size... any complexity... any process... at any location. Fluor's ever-growing reservoir of experience is gleaned from all the industries and fields it serves: petroleum refining, petrochemicals, chemicals, electric power, heavy construction, and atomic energy. We can thus apply many new ideas and techniques on the problems of any one industry.

And since we are equipped to accomplish *every* phase of a new facility—research, design, engineering, construction—we think in terms of the *entire project* rather than of an isolated part. The result is a 65-year record of successful plants with low initial investment and minimum operating costs.

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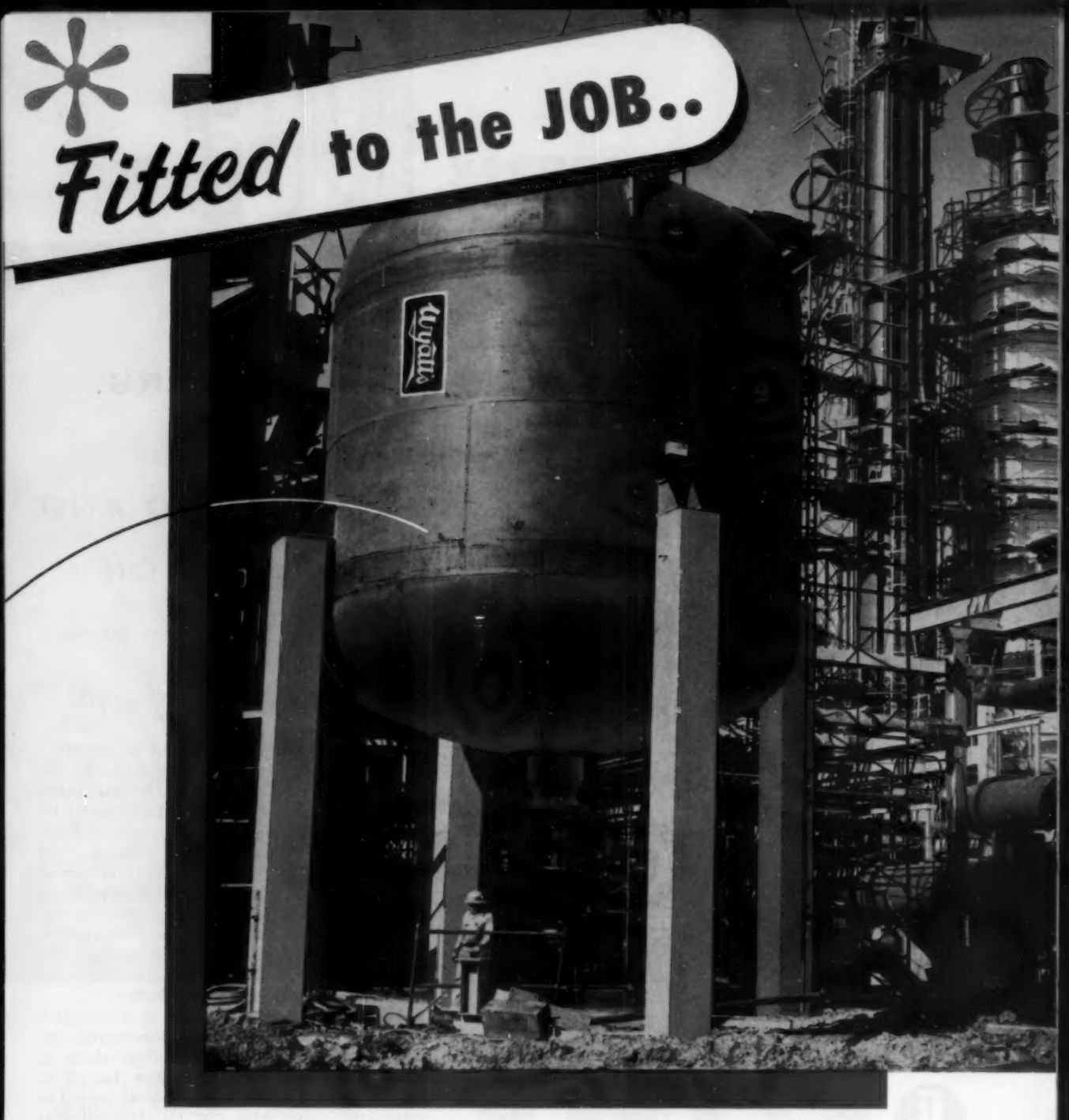

● This Reactor in the Expansion of a Gulf Coast Refining Plant operates at 530 pounds W.P., and temperature of 750°F.

Fabricated from ASTM A-204 Plate 3-11/16 inches thick: All seams 100% radiographed and completely stress relieved.

Shipped in one piece from Wyatt's Houston Plant to final destination.

*Overall Length 27 f[illegible], 2 inches
*Inside Diameter 18 [illegible], 3 inches
*Weight 215,000 pounds

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Visco's emulsion-breaking economy goes clear across the board . . . big operations or small . . . tough- or easy-to-break emulsions. It makes no difference whether you need a drum of emulsion-breaker a day or one every six months—you can be certain your Visco Field Service Man will find the right formula to give you dry oil at lowest cost. For fast action, call Houston, MAdison 3-0433, collect.

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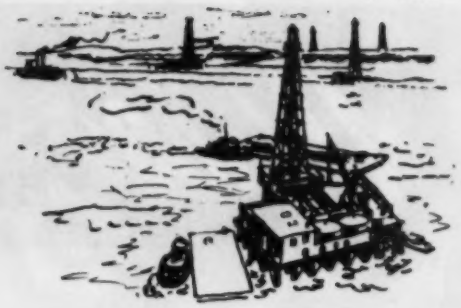
Visco® CONSISTENTLY EFFICIENT OIL FIELD CHEMICALS



Company Operations and Sales at All Time High in 1955

Ernestine Adams*

"ALL segments of the petroleum intry reflected the year's high level of business activity.

"Demand for oils averaged eight per cent higher than 1954. The total of petroleum products distributed to consumers in this country during the year exceeded three billion barrels for the first time in history."

Thus declared Cities Service in its annual report.

Nearly all companies shared in the even expansion of the petroleum industry. Only 7 out of 63 companies did not have larger operating revenues in 1955 than in 1954 and most of the 7 were fairly close to the 1954 gross.

Volume of sales and other income ran 12 per cent above 1954. The 63 companies in this survey had a revenue of nearly $26 billion (Table 1).

Here is the triumphant report of a prosperous company to its stockholders. The best year since its founding 67 years ago, reports Texas Pacific Coal & Oil Company.

"Our oil production was the greatest in the era of regulated production, and our net earnings reached an all-time high. Our capital stock was doubled, each stockholder receiving one additional share for each share owned. Cash dividends paid to stockholders exceeded those paid in any previous year."

Not every concern was as fortunate as Bishop but the first paragraph set the tone of annual reports for 1955:

"Bishop Oil Company's production by the end of 1955 increased more than 50 per cent over that of a year ago, making possible the largest earnings in the company's history. In December, for the first time, more than half of the company's crude oil was produced in Canadian fields."

A large net income increase with sales down was the Wilcox Oil record. Concerning the 52 per cent rise in profit the report stated:

"The two major factors responsible . . . were (1) increased production of crude oil (we completed over three times as many producing wells and drilled about half as many dry holes as in 1954); (2) a material improvement in the price structure of refined products."

About the drop in sales, Wilcox reports:

"A decrease . . . was due to a reduction in the brokerage of crude oil and to the carry-over into 1956 of a large quantity of No. 1 fuel oil which, normally, would have been sold in 1955. The carry-over was disposed of at an increased price in January, 1956."

COSTS AND PRICE

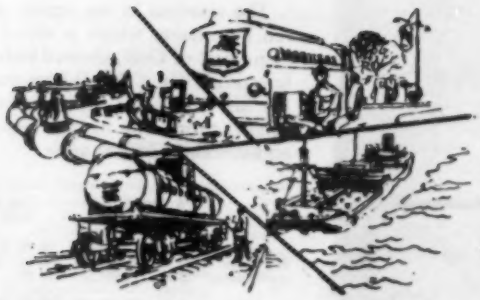
There was considerable discussion of costs with oil company shareholders. Although net income was 17 per cent above the previous year, the majority of the 63 companies had less than average increase. The net profit of 62 per cent of the companies did not reach a 17 per cent rise over 1954.

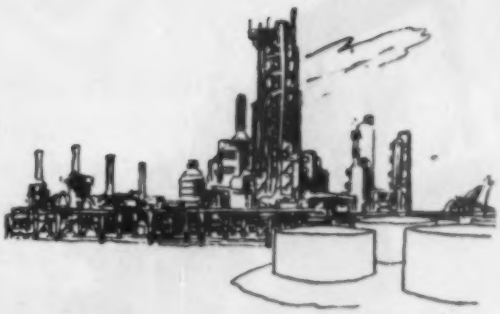
Highly competitive prices combined with unyielding advance in costs brought narrowing profit for many firms. Shamrock Oil & Gas reported that while its "net profits were somewhat greater than the previous year, earnings were adversely affected during a portion of the period by price disturbances in certain motor fuel marketing areas and to some extent by increased costs without corresponding increases in prices of products sold. Marketing conditions improved during the last quarter of the year and the management hopes for continued improvement during 1956."

Shell was another with a much larger volume increase than profit increase. In fact, only non-recurring profit kept the net from falling below 1954. The report explains it this way:

"This decline in the face of an appreciably higher gross income is attributable to a combination of a sharp rise in depreciation and amortization charges and an increase in operating costs, the former resulting from the substantial additions to plant completed during the year, greater drilling activity and amortization of the very large investment in Gulf Coast offshore oil and gas acreage. It is the company's practice to write off intangible drilling costs currently against income and to amortize lease acquisition costs over the term of the lease (or a maximum of five years) until production is established. On account of this and because of the increasingly heavy drilling program coupled with the very large recent investments in offshore acreage, there is a varying impact on the comparison of net income from year to year, and consequently the comparison of cash income, that is net income plus write-offs and amortization, at times

*Management Editor.





Sketches from Socony-Mobil Annual Report

Rise in income is due to greater volume and to more efficient operation.....Company reports show more interest in foreign areas and in U. S. offshore leases..... New emphasis is placed on management planning.

provides a better indication of operating performance." (See graph next page.)

Although Superior's gross income went up 4 per cent, it suffered a 67 per cent set-back in net. The increased $1,150,000 charged against income is mostly for depletion and depreciation on additions to properties during 1955.

Plymouth Oil protested that risen costs demand relief in a higher price for crude oil: "... largely because of burdensome imports, the industry has been chained to a wholly inadequate and unrealistic crude oil price structure. The industry has been compelled to make substantial increases in its capital expenditures and because of the lack of a proportionate per barrel increase in gross revenues, it has been forced into larger financing programs. While labor, wages, material and all other costs have mounted from year to year, there has been only one increase in the price of crude oil since 1948, and that of only 10 per cent.

"The domestic oil industry should not be required to bear the entire burden of subsidizing the development of foreign oil which, in the light of experience, would be of dubious value in the event of national emergency. As long as this development is carried on at the expense of curtailed production and inadequate price at home, it is nothing more than a subsidy paid out of the pocket of the domestic industry. It cannot be repeated too often that there is no security in foreign oil."

The refiners also needed price increases, Quaker State reported:

"Increased profits during the year resulted mainly from added volume and the sales gain of longer profit products. The oil industry continues highly competitive with an excess supply aggravated by increased imports. Product prices do not reflect quality improvement. Operating and transportation costs trend upward, as well as prices for purchased essentials of crude oil, containers, fuel, etc."

Another statement on costs came from Honolulu Oil Corporation:

"Industry costs and expenses for exploration, development and other operations have risen generally in excess of 20 per cent since the last crude oil price increase in 1953 and further increases in cost are facing the industry in 1956. It is imperative on the basis of sound economics that a general price increase affecting all gravities of crude oil be effected in the near future."

Union Oil & Gas of Louisiana gave these price comparisons from its own sales:

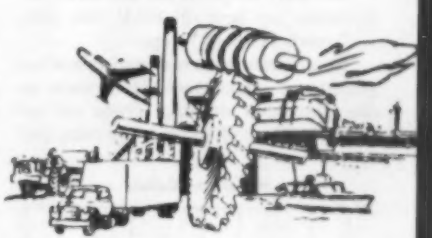
	1955	1954
Crude oil & condensate Avg. price/bbl	2.88	2.89
Gas liquids from plants Avg. price/bbl	2.02	1.82
Natural gas Avg. price/Mcf	0.09	0.09

CAPITAL INVESTMENT

Capital expenditures and exploration costs were on an upward trend.*

Heavy expenditures for capital investment needed to keep up with increased demand is mentioned in sev-

*This will be covered more fully in a later article.



1955 ANNUAL REPORTS SHOW

- **Revenues up 12%**
- **Net Income up 17%**
- **Direct Taxes up 21%**
- **Excise Taxes Larger**
- **Shareholders up 6%**
- **Employment up 1%**
- **Pay and Benefits up 6%**

Courtesy Pure Oil Company

Pipe line progress was made in 1955. The program of providing transportation for crude oil and for products was advanced much further, Pure Oil reported.

ral reports. Skelly Oil points out that in five years its net investment in property, plant, and equipment increased almost 50 per cent. During the same period stockholders equity went up 62 per cent.

Although the largest sums went to exploration and production not everyone seeks oil reserves. Ashland Oil & Refining feels that crude supplies available are more than adequate and is spending large capital funds on modernizing its refineries. Accelerated amortization makes this improvement practical and has limited the search for new supplies.

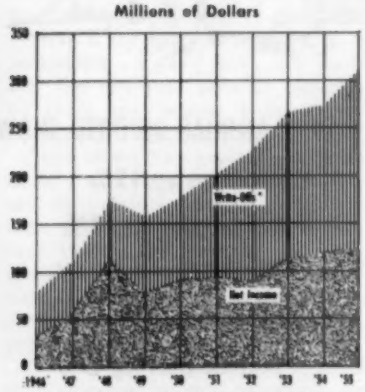
"We have no plans for extensive exploration for new oil fields this year . . ." reads Ashland's report.

"Some petroleum economists are beginning to attach less significance to the ownership of large crude oil reserves by diversified oil companies and more importance to the possession of markets for refined products. Our established markets, reflected by a sales volume of $245,000,000 in the past year, are probably our most valuable asset."

This was before recent action of the Office of Defense Mobilization closing the privilege of the refining industry to apply for fast amortization for tax purposes, which will affect refining expansion programs.

On the other hand Atlantic Oil & Refining is diligently seeking larger reserves. Its policy of heavy reinvestment, combined with increased expenses of this ambitious crude-finding effort, has held back increase in profit, making Atlantic one of the few with less net income than in 1954 although operating income was up 6 per cent. The report says the 1955 profit was better than anticipated.

Speaking of its oil search, the Atlantic reports: "Perhaps the intensity of this effort can best be shown by the fact that in 1955 our total cost for finding new crude oil — that is, geological and geophysical expenses, amortization of undeveloped leases and dry hole drilling — was approximately $30,000,000. As recently as two years ago the figure was only about $22,000,000. In 1956 it will be even higher than last year."



*Write-offs refers to depletion, depreciation, amortization, etc.

Courtesy Shell Oil

CASH INCOME. Shell shows in this graph the rise in depreciation and amortization charges.

TAXES

It was somewhat surprising that virtually no objection was made to taxes because direct taxes were up 21 per cent for the survey group and sales taxes on oil products collected by companies were growing by the day in volume and percentage-wise.

The mention in the report of Warren Petroleum, which is slated to become part of Gulf, showed only an interesting change in disbursements in the last year. The government got a smaller proportion in 1955; employees and stockholders got more.

	5 Years Ended 6, 30, 1954		Year Ended 6, 30, 1955	
	%	Amount	%	Amount
Government.	34.01	$25,723,631	19.79	$ 3,536,333
Employees...	52.95	40,045,936	60.14	10,747,800
Stockholders.	13.04	9,857,361	20.07	3,585,917
Total...	100.00	$75,626,928	100.00	$17,870,050

This propotion does not hold for the industry as a whole. Pay was up 6 per cent and taxes were up 21 per cent in 1955.

NATURAL GAS ACT

Instead of taxes this year's political theme was the President's veto of the Harris bill.

Stated General Crude:

"Recent veto of the Harris-Fulbright gas bill was a blow to supporters of free enterprise. This proposed legislation would have reduced the Federal Power Commission's control over field prices for natural gas, and restored freedom of competition to this segment of our industry. However, much more is at stake in this controversial issue than control over gas prices. It is the general belief that continued control over natural gas may ultimately lead to attempted regulation of all natural resources."

Union of California pointed out results already showing from Federal control of gas.

"The Harris-Fulbright bill, which passed both houses of Congress, would have corrected a previous decision of the Supreme Court which placed producers of natural gas under the FPC. The failure of this bill to become law is a serious threat to all business and may lead to complete price controls in any business selling to a public utility. This bill further recognized the risks, costs, and uncertainties of exploring for and producing natural gas.

"Decreased natural gas activities have been evident in our industry since the imposition of Federal price controls in 1954, a situation the Congress unsuccessfully sought to remedy through its approval of the Harris bill. By presidential rejection of the Congress' wishes, the long-term result for consumers will be less gas at higher prices."

Speaking of the effect of Federal control of natural gas production, the Woodley Petroleum report states: ". . . without the incentive of competitive price in the field, we cannot hope to find and produce petroleum in the enormous and growing volume which is required to fuel this nation in peace

TABLE 1

63 Oil Companies

Had a revenue of $25,986,448,000 . . . Up 12%
Making a profit of $2,788,077,000 . . . Up 17%
Paid direct taxes of $1,765,108,000 . . . Up 21%

Company	Income: Gross income ($1000)	Income: Per cent of 1954	Income: Net income ($1000)	Income: Per cent of 1954	Taxes: Direct taxes ($1000) 1954	Taxes: Direct taxes ($1000) 1955	Taxes: Collected for govts ($1000)	Common stock 1000 shares	Per common share 1955: Price 12-31-55	Per common share 1955: Net income	Per common share 1955: Direct taxes	Per common share 1955: Dividends
Amerada	$ 101,750	120	$ 25,364	128	$ 7,029	$ 9,304	—	6,309	$ 92⅝[6]	$4.02	$1.47	$1.75
Anderson-Prichard	61,291	112	4,965	153	998	1,474	—	813	58	6.10	1.81	2.00
Argo Oil	11,451	113	4,409	103	981	1,132	—	2,000	28¾	2.20	0.36	1.30
Ashland O & R[1]	245,881	108	10,106	152	8,018	10,774	—	5,434	15⅞	1.56	1.98	0.65
Atlantic Ref.	527,005	106	39,464	95	20,956	22,402	70,457	8,966	36½	4.25	2.50	2.00
Bishop Oil	2,363	128	534	173	—	128	—	547	13¼	0.98	0.23	0.25[9]
British American	271,066	111	20,613	114	23,475	26,782	42,226	9,100	37¾	2.27	2.94	0.85
Chicago Corp.	55,728	117	8,509	144	—	—	—	4,010	24¾	1.67	—	0.85
Cities Service	933,240	114	53,261	112	28,826	45,640	—	10,110	57⅛	4.88	4.51	2.10
Colorado O & G[14]	22,832	—	1,364	—	—	—	—	2,818	14⅝	0.28	—	none
Continental Oil	528,944	106	46,359	111	20,184	22,418	55,053	9,756	100	4.75	2.30	2.85
Cosden Pet.[2]	50,187	111	3,546	126	1,733	2,431	—	1,036	40	3.42	2.35	+1.00
Crescent Corp.	10,140	—	2,404	97	—	—	—	276	61	8.71	—	none
Delhi-Taylor	52,786	97	1,647	180	—	870	—	5,271	13½	0.31	0.02	none
Douglas, Calif.[3]	21,000	98	203	61	338	—	—	1,151	4⅝	0.18	—	0.25
General American[4]	23,420	168	7,678	117	1,086	1,765	—	1,368	50½	5.61	1.29	0.60
General Crude	12,891	106	3,506	109	1,389	1,213	186	1,886	33½	1.86	0.64	1.00
Gulf Oil	1,913,565	111	218,064	119	139,721	146,145	266,366	26,628	92½	8.19	5.49	2.25
Hancock Oil	9,777	90	6,112	89	621	919	—	3,238	31⅝	1.81	0.28	0.60
Honolulu Oil	36,336	118	13,699	134	3,436	4,178	—	3,751	62¾	3.65	1.11	1.50
Houston Oil	19,748	109	4,699	97	1,567	1,793	—	1,360	143¾	3.46	1.32	2.25
Husky Oil[4]	23,688	172	717	71	731	834	—	2,338	10½	0.19	0.36	25% st.
Kerr-McGee[4]	45,200	139	2,304	146	875	1,036	1,465	1,755	46	1.20	0.59	0.60
Louisiana Land & Exp.	25,070	105	13,438	104	8,361	8,732	—	2,981	94	4.51	2.93	3.75
Macmillan	1,381	101	116	359	128	120	1,542	1,040	4½	0.11	0.12	none
Mid West Oil	14,443	109	5,994	109	1,953	2,097	—	2,552	32	2.35	0.79	1.79
Monterey[10]	15,340	193	1,276	170	586	932	—	1,581	32⅝	0.81	0.59	0.80
Ohio Oil	260,145	104	41,255	108	16,647	20,666	24,915	13,127	34¾	3.14	1.57	1.55
Pacific Western	28,068	92	11,182	89	2,322	2,059	—	5,499	42⅝	2.03	0.37	stock
Panhandle Oil	12,681	99	902	94	396	356	2,950	1,593	11¾	0.57	0.22	0.30
Phillips Pet.	913,314	115	95,203	125	36,297	62,243	90,000	17,143	82⅛	5.55	3.63	3.00
Plymouth Oil	98,265	107	6,888	102	3,409	2,958	—	2,434	31⅝	2.83	1.22	2.10
Pure Oil	490,385	125	35,164	113	13,876	24,043	93,686	8,549	38¾	4.05	2.81	1.45
Quaker State	52,119	108	2,148	115	2,804	3,446	5,326	927	30⅝	2.32	3.72	2.00
Richfield Oil	245,295	110	29,609	116	20,241	26,911	51,165	4,000	78¾	7.40	6.73	3.50
Seaboard Oil	42,913	109	7,542	101	335	900	—	3,733	55¾	2.06	0.24	1.00
Shamrock O & G	43,181	113	7,756	105	4,329	4,031	—	2,262	41	3.43	1.78	1.90
Shell Oil	1,484,069	113	125,532[11]	104	100,995	116,715	225,905	27,533	64⅝	4.56	4.24	2.00
Signal Oil	58,913	109	15,563	101	3,652	3,516	6,163	3,273	31	2.46	1.07	0.70 st.
Sinclair Oil	1,110,067	109	80,710	108	51,157	59,854	182,000	14,197	57⅞	6.01	4.45	2.70
Skelly Oil	231,639	110	32,240	109	12,847	17,942	22,122	5,746	55½	5.61	3.12	1.80
Socony Mobil	1,839,349	108	207,434	113	103,454	96,885	258,362	34,982	64½	5.93	2.77	2.50
South Penn Oil	55,843	106	6,067	120	4,582	5,021	4,693	1,666	34⅝	3.64	3.01	2.50
Southern Prod.	17,156	75	4,347	104	1,237	1,379	—	1,727	34½	2.52	0.80	1.00
Standard, Calif.	1,376,558	112	231,139	109	94,118	107,585	171,028	31,612	91	7.31	3.40	3.00[11]
Standard, Ind.	1,813,954	108	157,118	134	74,024	92,913	288,354	33,057	51	4.81	2.81	2.40
Standard, New Jersey	6,414,885	110	709,310	121	432,900	544,400	451,000	65,435	152½[7]	10.84	8.32	5.25
Standard, Ohio	371,510	114	23,008	124	17,443	23,097	63,724	4,011	47¼	5.74	5.76	2.40
Sun Oil	663,748	100	48,307	120	30,171	36,687	149,738	10,236	75	4.72	3.58	1.00
Sunray Mid-Cont.[13]	298,387	238	39,472	170	15,442	26,163	—	16,442	23⅝	2.27	1.59	1.20
Superior Oil[5]	80,518	104	3,395	33	5,208	5,599	—	422	1010¾	24.54	12.33	3.00
Texas Co.	1,890,500	111	262,730	116	91,268	123,929	325,629	27,625	121½	9.57	4.51	4.25
Texas Gulf	16,077	121	6,320	120	976	1,651	199	3,670	42⅝	1.72	0.45	0.72
Texas Pacific	23,270	106	7,949	101	1,954	2,225	—	3,585	34¾	2.22	0.62	0.90
Tide Water	478,764	104	37,790	109	17,456	16,791	64,496	11,484	33¾	3.03	1.46	none
Union of Calif.	368,761	105	30,523	85	16,825	13,414	65,875	7,332	53½	4.13	1.83	2.40
Union O & G of La.	24,692	120	3,093	203	1,091	1,210	—	1,806	—	1.71	0.67	0.78
Universal Consol.	5,620	105	2,295	141	850	1,003	—	639	81	3.59	1.57	2.50
Utah Southern	3,146	115	1,052	104	—	431	—	1,200	12½	0.79	0.36	0.40[12]
Warren Pet.	110,036	98	10,121	113	3,393	3,536	—	1,887	71¼	5.36	1.87	1.90
White Eagle	13,365	147	258	146	none	9	—	1,499	15½	0.19	0.01	0.19 st.
Wilcox Oil	8,258	85	982	152	228	251	1,700	282	33½	3.48	0.89	1.00
Woodley	4,474	133	1,372	177	232	273	63	729	58½	1.80	0.37	0.50
Totals for 63 Companies.	**$25,986,448**	**112**	**$2,788,077**	**117**	**$1,457,984**	**$1,756,108**						

[1]Fiscal year ending 9/30/55.
[2]Fiscal year ending 4/30/55.
[3]Fiscal year ending 3/30/55.
[4]Fiscal year ending 6/30/55.
[5]Fiscal year ending 8/31/55.
[6]After 2 for 1 stock split.
[7]Now split 3 for 1.
[8]Plus 2% stock dividend.
[9]Over-the-counter prices are those bid.
[10]Monterey purchased Fullerton Oil & Gas 12/3/54.
[11]Plus 5% stock dividend.
[12]Sunray Mid-Continent merged May, 1955.
[13]Plus 2 for 1 stock split.
[14]Merged with Derby Oil Co. 11/4/54.
[15]Includes $119,417,000 non-recurring profit.

Courtesy Southern Production Company

A bulldozer breaks ice across a frozen stream and road leading to one of Southern Production's wildcat wells in Alberta, Canada.

and war. National security requires our producibility of petroleum be kept partially in reserve to meet the enormously increased demands of war emergency. The competitive price mechanism is the very key to the ingenious system which makes petroleum supply abundant. Price fixing at the source means not only less abundance of supply but also higher consumer prices in the long run."

Amerada repeated its last year's statement about public utility type regulation by the Federal government.

"The functions of the producer of natural gas are in no respect comparable with those of a public utility, and the unavoidable complexities of natural gas production are such that it will be impossible for the Federal Power Commission or any other governmental agency to establish formulas or yardsticks of general application to the producers for determining a fair price for the sale of their gas to the interstate pipe lines. Only by exercising in each case entirely arbitrary authority without regard to rule or precedent can such price fixing and regulation be carried out."

Louisiana Land and Exploration mentioned one petition it had concerning a gas contract and added: "A proposed amendment to the Natural Gas Act would have exempted, with certain exceptions, natural gas producers from direct Federal regulation and would have greatly clarified the Company's position in this matter. However, the President vetoed the bill and it failed to become law."

In giving a review of its subsidiary, Delhi Pipeline, Delhi-Taylor Oil Corporation supplied an example of the advantage of selling natural gas close to supply. Although the price is only slightly more than 13 cents a 1000 cu ft, the arrangement is of benefit since most of the gas goes to a nearby electric utility. Sales have gone from $185,000 in 1951 to $961,146 in 1955. Price per 1000 cu ft has remained steady.

FOREIGN OPERATIONS

Two distinct trends showed up in annual reports of operations. First were the increasing number venturing into foreign operations or, with those already in foreign areas, the greater attention given to property outside the U. S. Next was the intense interest in the offshore areas, principally in the Gulf of Mexico.

Although Standard Ohio recognizes there are still ample supplies of crude oil in the United States, it was looking for supplies for the future. Stated its report: "... known reserves of crude oil in this country are only about one-fifth of known reserves in the world today and many areas abroad remain untested. Our country will become more dependent on foreign oil in the years ahead.

"Our company, recognizing this trend, expanded its operations into two foreign areas in 1955. In April we made an initial and modest overseas investment when we became a participant in the Iranian Oil Consortium. Our second step in foreign operations was taken in November when we applied for exploration rights in Guatemala under a new and equitable law, which went into effect late in the year. . . . In 1956 we intend to extend our activities to the Province of Alberta, Canada, and are giving consideration to several other areas outside the United States."

Macmillan Petroleum is expanding its holdings in Sicily.

Signal Oil and Gas, an integrated California company, has gone into foreign operations through wholly-owned subsidiaries in Venezuela, Guatemala and Canada and in association with others (Aminoil) in the Neutral Zone between Kuwait and Saudi Arabia and in Iran (the Consortium).

Pacific Western for the first time had more foreign oil than domestic. From its U. S. holdings, it produced 10,245 bbl a day and from its interests in Saudi Arabia-Kuwait Neutral Zone, Iranian Consortium, and in Canadian Pacific Western Oil Company, it produced 13,390 bbl a day.

Richfield, which has interests in Egypt, Muscat and Oman, Peru, Canada, and Alaska, explains its search in foreign lands thus:

"It is inevitable . . . that sooner or later we must import oil regularly to some extent to meet the requirements of our expanding business. When that

Courtesy Ashland Oil & Refining Company

The motor vessel, *Aetna-Louisville*, shown en route from Louisiana to the refinery near Ashland with more than 200,000 bbl of crude oil, the largest single cargo ever moved up the rivers.

time comes, we think it is to the benefit of our stockholders that the oil we import be, to the greatest extent possible, oil that we ourselves have produced or in the production of which we have a financial interest."

General American is seeking oil in Canada and Spain. "Plans to expand the Spanish operations," read its report, "include the shipment to Spain of a second drilling rig and parts and equipment needed to support two drilling operations. Geological, geophysical and gravity meter work will be continued. Relations with the Spanish officials with whom the American group is working in this program, continue to be most satisfactory."

OFFSHORE OPERATIONS

One of the veterans of offshore operations, Continental, reported:

"Continental participated in more extensive drilling operations in the Gulf of Mexico than in any previous year. These efforts resulted in a number of discoveries. At the end of 1955, Continental owned working interests in 62 producing oil wells, 8 producing gas wells, and 22 shut-in gas wells off the Louisiana shore."

Southern Production got further into Gulf operations by buying controlling stock in The Offshore Company:

"The Offshore Company is a pioneer in the operation of mobile drill barges in deep waters in the Gulf of Mexico. It owns the first barge ever to lift itself from the surface of the water and then to drill a well from its own deck. During 1955 the second and third mobile deep-water drill barges were placed in operation in the Gulf of Mexico. Offshore has thereby acquired information about winds, waves, bearing capacity of oils and other elements of operation which makes it a leader in deep-water drilling."

Standard of California reported:

"From the standpoint of additions to reserves, perhaps the most significant development of the year was the extension of the company's offshore holdings in the Gulf of Mexico. The two subsidiaries operating in that area have leases on 25 prospects in submerged areas offshore. Eleven prospects have been drilled. Six of them were established as producers, three are awaiting further drilling and two have been abandoned as unproductive. Acquisition of these properties is by competitive bidding to the Federal or State governments, depending on which holds title. Some of the geologic structures sought are large and well-recognized. The leases are offered in sizable blocks with the result that substantial outlays of cash are required to bid successfully and the size of bids has increased greatly in the last several years."

MANAGEMENT PLANNING

One thing is certain. Top-level planning works for a better and more productive future. Management is at last getting its share of attention in this era of scientific industry and complicated organization. Of course, there has always been planning — but it is becoming more a design for the future, carefully made.

Sinclair goes into the problems of management in this day of rapid progress and the need for planning:

"The accelerated pace of industrial development, a trend which will inevitably continue, probably at an even greater rate, intensifies the problems of corporate management. In our organization we call three of the most important problems "plans, people and properties."

"In the affairs of an integrated oil company one is dealing, in effect, with a number of diversified and dissimilar businesses. There is the finding and garnering of raw material, specialized land and ocean transportation, manufacturing, selling, and the ever-vital research effort. In bringing these threads together we must plan, and plan carefully, for a well balanced operation. We need to probe the future as intelligently as we are able. We must establish a clearly defined goal and make a keen appraisal of the resources that it will take to do the job and of the avenues through which we may expect to derive those resources.

"At the same time we must be ingenious and flexible enough to change course should unexpected circumstances arise. In our rapidly changing era, unexpected circumstances may arise with disconcerting suddenness."

Plans for management changes were evident in several reports. White Eagle spoke frankly to its shareholders:

"We feel very strongly here in the company that our success in the future depends principally on a strong and alert management; too, that this managerial responsibility should not depend on one or two men but should be distributed over a group of outstanding executives. In believing so strongly in this basic premise, we have shifted the emphasis of management to several operating committees.

"In addition to these operating committees we have established several staff committees and staff positions. Supplementing these head office changes we have added many highly trained personnel to our field operations. Every means has been used to establish closer communication and to strengthen all administrative controls throughout the various operating divisions. Many of our accounting procedures have been materially improved and additional work is being handled by machines; all of this has been approached under an overall plan for more positive management control."

Gulf has turned to decentralization in its search to improve management. Under a paragraph on "decentralization and coordination," its report says:

"The great size of the petroleum industry calls for the best of management techniques to handle the far-flung operations. Your company has responded with increased decentralization of action and intensified coordination of policies in order to improve and simplify the conduct of this large, expanding, and highly technical enterprise with its wide geographic spread."

Long-range planning is evident in Socony Mobil's report:

"One of Socony Mobil's basic policies combines an open mind toward

Courtesy Continental Oil Company

Pembina field in Canada was mentioned in several reports. This Hudson's Bay Oil and Gas Company (Conoco 75%, Hudson's Bay Co. 25%) well extended Pembina westward.

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TABLE 2

Oil and Gas Operations in 1955

Note: It is more difficult to get uniform figures for operations than for finances. Some give only gross wells drilled and production; some include foreign operations and others do not. One of the most interesting points here is that for those who gave the data, one in four wildcats found production.

Company	Net lease or fee dev. or undev. 1000A	Net wells drilled 1955	Net oil producers	Net gas prod.	Net wildcats	Net discoveries	Net producing wells owned	Net crude oil and gas liquids production b/d	Net gas production MMCF per day	Crude oil capacity of refineries	Crude oil runs to refineries b/d	Estimated reserves: Oil and LPG million bbl	Estimated reserves: Gas billion cu. ft.
*Amerada	8,245[4]	398[4]	244[4]	29[4]	—	—	2,963	85,554	—	—	—	—	—
*Anderson-Prichard	579	128	83	6	25	8	827	12,155	40	28,500	24,827	—	—
Argo Oil	518	59	36	—	—	—	296	11,716	—	—	—	90	—
*Ashland O & R	—	47	27	—	—	—	—	8,048	—	—	110,383	—	—
*Atlantic Ref	5,591	257	155	25	—	—	3,884	101,518	412[2]	210,000	196,215	515	2,650
*Bishop Oil	77	19	18	—	2	0	304	2,573	—	—	—	—	—
*British-American	—	289[4]	138[4]	19[4]	—	—	—	28,753	—	95,700	88,546	113	404
Chicago Corp.	1,285	134	76	12	50	15	1,692	12,993	—	30,000	21,175	—	—
*Cities Service	8,407	323	—	—	—	—	—	113,633	678	271,000	263,600	—	—
*Continental Oil	8,819	557	411	20	105	29	6,106	156,444	350	142,550	141,198	—	—
*Colorado Oil & Gas	699	109	41	54	11	5	630	4,145	14	16,000	13,164	—	—
Coaden Fst	109	—	—	—	—	—	—	2,590	—	—	23,532	19	17
Crescent Corp.	—	26	18	3	6	2	75	1,148	2	—	—	—	—
*Delhi Taylor	612[7]	48	28	8	—	—	—	3,825	159	47,500	28,220	47	2,255
*Douglas Calif	—	—	—	—	1	1	41[4]	1,147	—	—	15,487	—	—
*General American	—	56	45	—	—	—	3,544	30,709[4]	—	—	—	110	256
General Crude	733	67	17	2	50	8	416	11,000	—	—	—	—	—
*Gulf Oil	73,257	1,122[4]	—	—	179[4]	—	21,595[4]	886,186	591	519,000[9]	587,867	17,040	8,200
Honolulu	2,064	112	95	4	11	2	1,292	34,300	50	—	—	—	—
Houston Oil	959	106	36	23	42	10	606	15,305	73	—	—	78	98
*Husky Oil	403	98[4]	59[4]	—	38[4]	11[4]	229	5,659	6	6,500	4,776	—	—
*Kerr-McGee[8]	1,198	21	12	3	—	—	418	6,609	83	35,000	35,000	—	—
Louisiana Land & Exp.	873	12	10	1	—	—	70[6]	18,706	29	—	—	—	—
*Macmillan	—	—	—	—	—	—	17	193	—	11,000	8,766	1	—
Mid-West Oil Corp	277	58	27	3	25	6	820	12,940	17	—	—	—	—
Middle States Pet.	2,459	—	—	—	—	—	—	8,742	45	—	—	32	239
Monterey Oil	377[7]	38	25	1	14	2	642	16,580	11	—	—	69	—
*Ohio Oil	4,330	644	349	26	111	15	7,418[8]	98,404	256[2]	46,500	42,421	666	2,110
*Pacific Western	456	54	45	—	—	—	556	23,635	—	—	—	—	—
*Panhandle Oil[1]	241	28	—	—	—	—	450	3,493	11	7,500	5,874	15	55
*Phillips Pet.	9,403	453	352	27	44	14	8,114[8]	192,778[8]	1,729[2]	240,000	228,653	961	13,200
*Plymouth Oil	852[7]	65	42	3	—	—	872	17,647	94	—	31,082	—	—
Pure Oil	4,177	271	198	16	44	11	5,540	71,451	269	182,300	167,715	—	—
Quaker State	—	39	—	—	—	—	—	1,962	—	—	8,415	—	—
*Richfield Oil	356	77	44	2	—	—	1,273	56,792	193	130,000	121,940	—	—
*Seaboard Oil	—	162	123	—	—	—	—	38,148	94	—	—	—	—
Shamrock O & G	634	123	87	20	20	9	735	13,759	200	15,500	13,379	88[10]	1,700[10]
*Shell Oil	21,369	899	628	55	207	52	8,741	312,150	955	561,000	463,000	1,250	—
*Signal Oil & Gas	—	72	67	—	9	3	1,025	54,160	59	—	—	—	—
*Sinclair Oil	10,163	665	487	40	90	21	10,086	155,861	277[2]	476,000	430,613	825	2,000
Skelly Oil	4,727	461	323	39	48	15	4,551	85,226	330	—	46,697	351[11]	2,300
*Socony Mobil	12,397[8]	822[8]	631[8]	63[8]	67[8]	17[8]	14,212[8]	607,211[12]	885[8]	790,000[12]	729,132[12]	8,421	8,400[8]
South Penn Oil	714	—	—	—	—	—	13,807	10,254	—	—	8,791	34	63
*Southern Prod.	1,568	42	25	1	—	—	655	11,605	147	—	—	51	972
*Standard, Calif.[13]	41,803	822	679	26	117	34	8,634	677,335	461	499,000	692,510[12]	—	—
*Standard, Ind.	16,181	847	555	123	142	38	11,935	274,100	1,086	655,800	601,500	2,097	11,890
*Standard, N. J.	—	—	—	—	—	—	—	1,863,000	—	—	2,271,000	—	—
*Standard, Ohio	2,225	164	100	5	49	6	2,024	31,406	108	139,500	129,411	—	—
*Sun Oil	12,638	510	299	43	183	63	4,577	115,378	—	246,000	238,700	752	3,480
*Sunray Mid-Continent	5,072	381	257	18	109	29	5,269	84,778	312	113,000	99,400	—	—
*Superior Oil	—	301	226	—	—	—	—	61,414	—	—	—	—	—
*Texas Co.	27,003	1,469	1,036	96	—	—	—	433,540	822	—	634,550	15,731	11,734
*Texas Gulf	242	47	39	1	—	—	365	13,089	47	—	—	—	—
*Texas Pacific	1,220	104	72	1	22	6	—	20,555	73	—	—	—	—
*Tide Water	2,671	227	149	17	48	8	5,793	97,697	274	137,000	167,200	576	2,525
*Union of Calif.	3,599	296	198	9	101	25	3,511	110,661	173	189,600	164,043	538	1,988
*Union O. & G. of La.	910	45	10	15	11	7	279	11,650	166	—	—	—	—
Universal Consolid.	38	8	4	1	3	0	273	6,163	4	—	—	—	—
Utah Southern	300	42	10	1	29	5	53	3,713	—	—	—	—	—
Warren	1,273	148	113	—	—	—	—	40,000	53	—	—	—	—
White Eagle	361	71	54	4	16	9	782	2,951	16	—	—	—	—
Wilcox Oil	148	—	35	—	—	10	389	2,626	—	6,000	4,683	—	—
*Woodley	421	115	88	—	21	5	416	5,043	—	—	—	—	—

*Includes foreign operations.
[1]Petrofina, an international Belgium company has bought 600,000 shares of unissued common stock.
[2]Of this 67,600 b/d were natural gas liquids.
[3]Sales only.
[4]Gross.
[5]For year ending June 30, 1955.
[6]Also royalty interest in 641 wells.
[7]Undeveloped only.
[8]Plus working interest in 7435 wells operated by others.
[9]U. S. only.
[10]Estimate for December, 1954.
[11]Estimate for January, 1953.
[12]Western hemisphere.
[13]Western and Eastern hemispheres.

anything new with a reluctance to go overboard in any one direction. Under this policy we have taken risks — and achieved some success — not just in one producing area, but in every major producing area in the free world. Under it we pioneered in exploration in the Gulf of Mexico. In the furtherance of this policy we have entered the field of nuclear research. We also have assured ourselves a position in any future development of oil-bearing shale by acquiring an interest in shale lands in Colorado.

"This policy has sometimes resulted — where the costs and risks are great — in our entering joint ventures rather than going it alone. We have done this in the Gulf and in some overseas operations as well. We now are participating in a joint effort by a number of American business enterprises in construction of the first nuclear reactor to be owned and operated by private industry for research. In addition, we plan to establish our own nuclear research laboratory adjacent to the reactor."

Planning has a progressively better opportunity of success as electronic computers come into use, as communications are improved, as statistics are compiled and interpreted, as research probes farther into scientific fact and surmise.

It is interesting to record in 1955 that a noticeable amount of space in annual reports is a serious analysis of company planning for the long-term future.

PERCENTAGE DEPLETION

Not so many reports as usual mentioned the percentage depletion provision. The Texas Company had this to say:

The depletion allowance provision of the nation's tax laws is again being questioned. This allowance provides oil producers with the incentive to continue the costly and risky search for petroleum. Experience since the present provision was adopted in 1926 has proved its effectiveness. With the constantly increasing cost of drilling, the necessity for deeper holes, and the higher cost of lease acquisitions, any reduction in the depletion allowance would adversely affect the industry's ability to provide adequate reserves over the years ahead.

"The President's Materials Policy Commission in 1952 predicted that the nation's requirements of petroleum would be 13.7 million barrels per day by 1975. We believe this is a conservative estimate as it would be an increase of only 60 per cent over current demand levels during the next 20 years. If such increase were to be met from domestic production and adequate oil reserves maintained, the industry would have to find in excess of 100 billion barrels of additional reserves over the next 20 years, or an average discovery rate of over 5 billion barrels annually. As the annual discovery rate from 1946 through 1955 was only 3.6 billion barrels, the urgent need for continuing the depletion incentive should be clear. The incentive character of the depletion allowance principle has been recently recognized abroad by being incorporated in the petroleum and tax laws of several foreign countries."

TABLE 3.

More People in the Petroleum Industry

37 OIL COMPANIES HAVE . . .

1,574,686 Stockholders . . Up 6%

588,339 Employees . . . Up 1%

$3,411,523 Pay & Benefits . Up 6%

Company	Holders common stock 1954	Holders common stock 1955	Employees 1954	Employees 1955	Payrolls and benefits ($1000) 1954	Payrolls and benefits ($1000) 1955
Anderson Prichard	4,150	4,500	856	880	$ 4,946	$ 5,137
Ashland	30,788	31,172	4,200	4,300	21,951	24,000†
Atlantic	45,271	48,909	21,191	16,511	101,656	98,819
British American	25,659	26,939	5,535	5,765	26,224	28,242
Continental	29,150	29,283	9,348	9,366	54,540	58,800
General American	1,268	2,165	350	609	1,702	2,569
General Crude	1,072	1,076	251	225	1,525	1,442
Gulf Oil	69,140	73,705	46,800	47,200	224,867	230,850
Honolulu Oil	3,772	4,174	499	594	3,551	3,951
Houston Oil	3,566	3,745	438	449	2,745	3,259
Kerr-McGee	2,218	2,935	1,250	1,325	5,768	7,357
Louisiana Land & Exp.	7,327	7,623	78	86	578	640
Macmillan	1,550	1,713	270	280	1,633	1,529
Mid West Oil	7,743	7,597	70	82	601	706
Ohio Oil	32,912	37,134	6,449	6,616	35,508	38,004
Panhandle Oil	5,000	5,500	305	280	1,535	1,500
Phillips	82,367	90,246	23,848	25,208	145,292	155,329
Pure Oil	31,084	35,041	12,173	12,869	58,779	65,785
Richfield	11,875	12,000	5,520	5,666	31,737	33,939
Shell Oil	18,669	19,025	35,275	38,845	231,608	265,223
Signal O. & G.	2,500	2,600	1,127	1,161	6,146	6,740
Sinclair	101,285	107,163	23,746	24,657	130,916	139,530
Skelly Oil	5,081	5,642	4,754	4,875	23,856	24,929
Socony Mobil	174,627	174,300	43,800	43,900	281,100	301,100
South Penn	9,526	9,921	2,434	2,428	10,430	10,133
Standard Calif.	114,607	119,793	35,354	36,369	211,883	224,276
Standard Ind.	122,100	132,800	51,270	51,520	323,100	330,800
Standard N. J.	297,000	324,000	155,000	153,000	803,900	838,700
Standard Ohio	33,206	36,864	11,155	11,279	60,530	651,98
Sun Oil	18,742	20,778	18,216	18,358	103,661	108,469
Texas Co	119,532	120,376	41,630	42,548	232,990	245,674
Texas Gulf Prod	5,700	6,934	205	215	1,430	1,518
Tide Water	17,576	17,019	9,338	8,642	52,738	50,150
Union of Calif.	44,371	46,175	8,679	8,839	54,989	59,221
Universal Consol	2,140	2,600	112	101	643	678
Wilcox	1,709	1,723	217	215	1,062	1,104
Woodley	1,116	1,416	76	76	481	498
TOTAL FOR 37 COMPANIES	**1,485,399**	**1,574,686**	**581,819**	**585,339**	**$3,256,601**	**$3,435,799**

IMPORTS

There was not the usual emphasis on imports by either domestic producers or importers.

Mid-West Oil blamed imports for domestic lag in production:

"The high level of imports of foreign oil maintained during 1955 resulted in continuation of rigorous curbs on production in the states having proration laws. The effect was felt by all domestic producing companies including our own. While the total net production for 1955 is the highest attained since the merger in 1951, even a mild relaxation of the restrictions now being imposed would result in our production being substantially increased."

Several others, such as Plymouth (see "Costs and Prices" Pg. E-2), refer to imports. Many of the smaller companies, however, are endeavoring to become importers themselves.

PEOPLE

Although the number of employees in 37 oil companies increased only 1 per cent, this was against the U. S. trend. (Table 3). Factory workers in 1955 were almost 6 per cent less than in 1953.

Smaller but expanding companies were increasing personnel. For instance

Courtesy Phillips Petroleum Company

Supervisory conferences are part of Phillips long-range management development program.

Colorado Oil and Gas Corporation added 90 persons to its staff in 1955 for a total of 491 employees. It is not listed in the table because pay and benefits were not available. There were enough of these personnel increases to raise the overall percentage.

General American, with its present expansion policy increased employees from 350 January 1, 1955, to 609 on June 30, 1955.

Another expanding company, Husky of Wyoming, had gone from 239 to 1017 employees in one year.

Tide Water was one of several companies which reduced number of employees in 1955. Greater expenditure on equipment, more automation accounts for this reduction. It is spurred by increases in payrolls and benefits. States the Tide Water report:

"Total employee benefits paid by the company for the year, including its contributions to the pension and thrift plans, as well as allowances for vacations, paid holidays, sickness and accident benefits, group life insurance, and many other items, amounted to $10,924,000, or 24 per cent of direct payrolls, exclusive of these benefits."

For 37 companies the rise in pay and benefits was 6 per cent in one year.

One of the companies with outstanding employee relations is Sun Oil, which last year again engaged Opinion Research to survey employee opinions. Sun's annual report calls this "one of the recognized marks of a progressive corporation", as indeed it is.

Part of Sun's employee relations is the educational assistance plan, explained in the report: "Sun Oil is one of several companies in the oil industry to offer financial assistance to employees who desire to enroll in education institutions for courses of study which will better fit them for their work. Any full-time, permanent employee who has been with the company for one year is eligible. Under the plan the company will reimburse an employee who completes an approved course for one-half the cost of tuition, books, equipment and general fees."

Educational endowments outside of company employees were covered in Jersey Standard's report to its shareholders:

"The establishment during the year of the Esso Education Foundation was, we believe, also in your interests as Jersey shareholders. This foundation, set up by the parent company and certain of the domestic affiliates, offers financial support to private colleges and universities in the United States. Such aid is important because it is from groups of educated men and women, to whom privately supported institutions of learning make a unique contribution, that business organizations like Jersey Standard must draw many of their skilled employees. For this and other important reasons, independent education is a significant part of the free enterprise system."

Stockholders of oil companies were undeniably increasing. There is no practical method of cutting out duplications so the 6 per cent increase in number of shareholders undoubtedly included a number of duplications but most companies were satisfied with the increase in their own number of stockholders.

Splits were one method designed to increase the number of shareholders. Pure Oil Company report stated: "Your directors are firmly convinced that widespread ownership of the corporation's stock by the general public and also by its employees is beneficial to the company welfare. The directors hoped, in recommending the two-for-one common stock split, that this step would tend to broaden the base of ownership. These hopes appear to have been fully justified. During 1955 the number of common shareholders of record increased by 3957 or approximately 13 per cent."

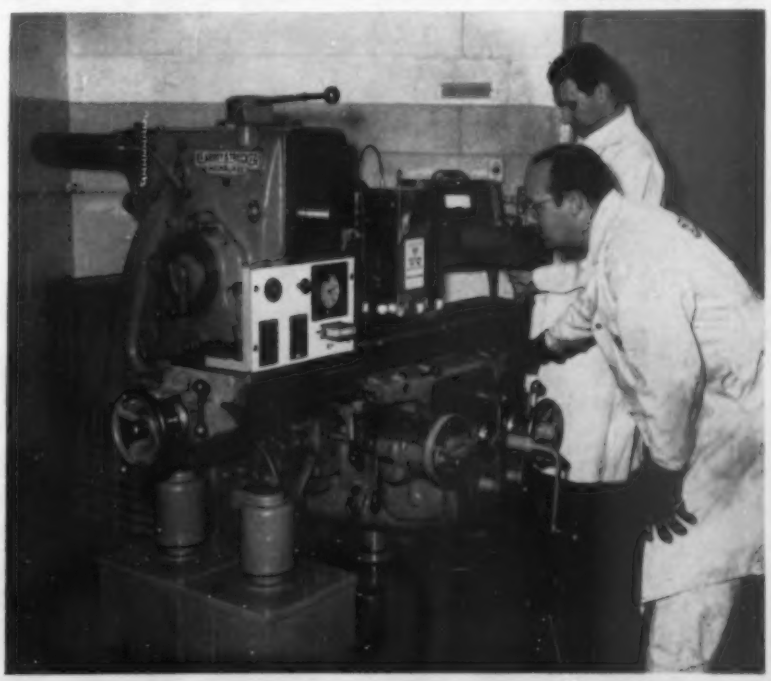
Share owners, employees, customers and the public are aimed at in Standard of Indiana's statement on public relations. This company "has adopted a platform that defines in broad terms our goals, policies, and principles. In the following 71 words, it seeks to spell out the truths we live by.

"We are in business to find oil, make good products, and sell them at fair prices and profits.

"We try to operate in the best in-

Radioactive materials are research tools of increasing importance to Sinclair scientists. Equipment below employs radioactive tool bits to measure the effectiveness of cutting oils. New "hot lab" is planned to test nuclear materials on refinery processes.

Courtesy Sinclair Oil Corporation



Courtesy Argo Oil Corporation

Dually completed well in Prentice field, Terry County, Texas. The "horses," head to head, are pumping from the Glorieta and Clearfork formations on two strings of tubing.

Courtesy South Penn Oil Company

Interior of water plant supplying 585 water intake wells in Bradford, Pennsylvania, field. Secondary recovery methods are still improving.

terests of share owners, employees, customers, and the public.

"We believe our company — and all business and industry — can do this best under American free enterprise and competitive, private management.

"Our public relations policy is to treat people right, heed their opinions, and keep them informed."

MERGING AND MIXING

There were a number of mergers and purchases but another crop of companies sprang up and the total number on the stock markets are about the same.

One of the big mergers of the year was that of Sunray and Mid-Continent. Exact comparisons with the previous year are not available but the net income for the merged company was $2.27 per common share after payment of preferred dividends in 1955 while the pro forma earnings in 1954 (Sunray and Mid-Continent together) were $2.01 per share.

Oil and gas properties and other assets of Houston Oil Company of Texas were sold to Atlantic Oil and Refining. This and other liquidation arrangements will bring an estimated $166.25 per share to common stockholders.

Lion Oil has become a subsidiary of Monsanto Chemical.

The new name "Crescent Corporation" was taken after "Deep Rock" sold its marketing, pipe line, refining facilities and trade name to Kerr-McGee. The company had already sold its Cushing, Oklahoma, refinery and some other properties to General American in 1954. Crescent becomes a crude oil and natural gas producer headed by W. H. Garbade. One investment is 17 per cent interest in Siboney, with operations in Cuba.

This new pipe pulley is part of the reconstruction at Whiting, Indiana, following the fire in late August.

Courtesy Standard of Indiana

One problem of sales and mergers was met satisfactorily by Crescent Corp.: "Crescent is pleased that it was able to protect its employees with respect to job tenure and related benefits in the sale of its properties. Those employees not retained by Crescent were offered employment in their same or commensurate positions along with their retirement benefits. This transfer of personnel involved approximately 550 people, and we are proud of the orderly and equitable manner in which it was made."

Mid-West Refineries and Roosevelt Oil & Refining were merged with Leonard Refineries of Alma, Michigan.

Petrofina, the Belgian company, proposes to purchase 600,000 shares of Panhandle Oil Corporation common stock now authorized but unissued. Consummation would provide Panhandle with $6,700,000 of new cash funds for expansion and would bring cooperation and assistance from Petrofina for Panhandle operations.

South Penn and Pennzoil were merged in July, 1955.

CABBAGES AND KINGS

As usual the annual reports of petroleum companies talked of many things. They talked of chemicals (for cabbages) and uranium (for kings).

They talked of history. Socony Mobil moves to a new headquarters building after 70 years on lower Broadway.

Getting ready for its 50th anniversary, British-American uses its annual report for an historic review. Every year since it was organized this company "increased in size, scope, and acceptance," reads the report. To do that some high-powered expansion was needed and accomplished:

"Under the presidency of Ole Berg, Jr., and latterly under the direction of M. S. Beringer, first man to assume the responsibilities of chairman of the board of directors and president, the

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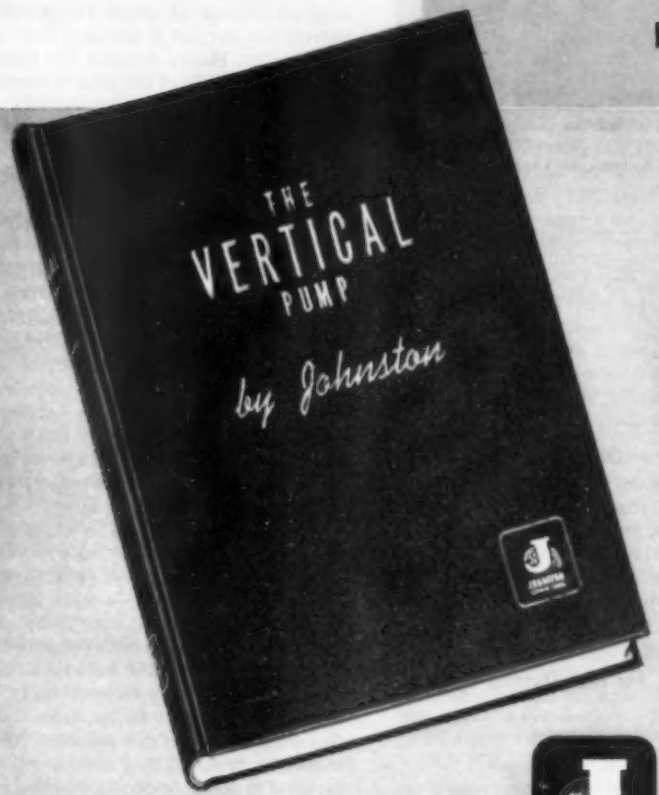

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Courtesy Standard Oil (Ohio)

A modern analog computer was added to Sohio's research facilities in 1955. It will make possible high-speed solution of complex engineering problems.

dynamic pattern of long-term plans, now consonant with B-A, continued to unfold: completion of the Trans-Northern and Platte Pipe Lines; the petrochemical B.A.-Shawinigan plant in Montreal East; a new grease plant at Clarkson refinery; *BA Canada*, a new ocean tanker; catalytic cracking units at Moose Jaw and Clarkson refineries; a B-A office building in Vancouver; catalytic reforming units at Calgary and Montreal East refineries, and a third planned for Clarkson."

Kerr-McGee, which has expanded into all phases of the oil and gas industry, has also got into uranium. It reports on operations of its uranium processing plant at Shiprock, New Mexico. The first oil company in this field, the company took in $2,767,230 on sales in the uranium division.

Research held its own in annual reports. It was revealed more and more as the base for greater expansion in the industry. Phillips Petroleum put it this way:

"Your company is known as a growth company in a growth industry. Our research continues to develop new products and processes. The experience gained from the wide variety of our petroleum and chemicals manufacturing activities permits the prompt evaluation of proposals for new projects."

Automatic equipment was mentioned in several reports and it was drawing more and more attention in planning. South Penn Oil stated:

"In recent years your Company has regularly reviewed the possibility of applying the principles of automation in its various departments. Automatic devices have been in service in the Producing Division for some years, and all newly installed refining equipment has been fitted with controls approaching automation. For some years past the accounting detail has used I. B. M. equipment to great advantage. To apply electronic principles to the overall accounting detail, however, requires the proposed benefits be carefully studied and evaluated and no such automatic computing devices adopted until it has been determined the cost and operation can be justified from an economic standpoint."

OUTLOOK

What does the future hold? There was much more assurance than in the annual reports for 1954. At that time the weakness of the 1954 market commanded a cautious approach to predictions for 1955. Even optimistic managements hedged after predicting 3 to 5 per cent gain in demand.

But consumption passed an 8 per cent rise and another 4 per cent is promised for 1956 so the future looks good.

Texas Gulf Producing report reads:

"After the record petroleum demand last year which ran 8 per cent over 1954, it is interesting to note that most industry forecasts predict a futher gain in 1956 of some 4-4½ per cent over 1955. In the month of December, 1955, oil demand was at an all-time high, running an average of about 10,500,000 barrels per day, or 9 per cent over a year earlier. Heavy demand for heating oils, as a result of the coldest winter in many years, was the principal factor in the big demand upsurge. . . .

"It thus appears that U. S. producing companies may look forward to an active and profitable 1956, if imports of foreign crude are not allowed to exceed the 1954 level, as recommended by the President's Cabinet Committee on Energy Supplies and Resources Policy."

The Ohio Oil Company finds politics an uncertain influence over 1956:

"The general economic outlook is clouded by many factors, including political uncertainties. It does not seem likely that industrial activity can continue to increase uninterruptedly as during 1955. Even if its average level exceeds somewhat the industrial activity of the past year, 1956 will probably lack its exuberance. Since the experience of the past two years confirmed the belief that changes in petroleum demand are dependent on fluctuations in general business activity, it would appear that the increase in domestic demand for petroleum in 1956 cannot be expected to be more than the normal four to five per cent. This should be matched by a corresponding increase in domestic production and refinery runs to stills, provided imports do not increase substantially again."

Experts from government and from private industry, taking the pulse and temperature of the boom, have found it extraordinarily healthy despite its age. Oil company reports for the first quarter in 1956 saw both gross and net income outdoing 1955.

Jersey Standard warned against inflation and this appears to be the greatest present danger. The Administration has increased interest rates and private companies find automation provides more efficient operations and a balance for increased personnel.

From all indications, 1956 is on the way to breaking the top records of 1955. It promises to be a year to remember — a year of huge investment, great improvements, outsize volume, large profit although not the record profit percentage, and a tax bill that only dynamic growth could pay. ★ ★

Income for First Quarter 1956.*

Company	Gross income ($1000) 1956	Gross income ($1000) % of 1955	Net income ($1000) 1956	Net income ($1000) % of 1955
Argo	2,954	108	2,168	173
Atlantic	148,486	104	12,223	123
Cities Service	267,032	107	18,180	129
Continental	144,635	111	13,795	113
Delhi-Taylor	—	—	1,106	175
General Crude	3,275	100	900	94
Gulf Oil	—	—	69,319[1]	153
Houston Oil[2]	10,840	112	2,166	105
Husky Oil	7,693	133	477	165
Mid-West Oil	3,610	104	1,600	100
Panhandle Oil	—	—	287	137
Phillips	258,879	122	28,332	128
Plymouth	—	—	2,263	103
Shamrock	12,381	125	2,573	121
Shell Oil	401,626	113	35,010	122
Sinclair	—	—	24,000	113
Socony Mobil	—	—	62,000	119
Standard Calif	360,993	116	61,494	116
Sun Oil	—	—	12,255	105
Sunray Mid-Con	—	—	11,300	133
Texas Co	—	—	69,958	125
Texas Pacific	—	—	2,054	102
Universal Consol	1,556	150	898	179
Warren Pet	—	—	2,851	112
Wilcox Oil	2,711	138	300	64

* Preliminary or estimates.
[1] Includes estimated earnings of Warren Petroleum for March, 1956.
[2] Stockholders approved liquidation. Oil property sold to Atlantic.

Technology is changing so fast today that you must use every tool on short and long-range plans . . . Automation is one of the essential elements for U. S. business in . . .

Planning for Future Success

Dan G. Mitchell*

EVERY major company not only is spending a great deal of time planning, but has actually set up some group to needle the rest of the organization into doing it. The reason is obvious: Those companies that don't plan for tomorrow, won't be here tomorrow. It's as simple as that. The things we make are increasingly complex, and the ways of making them are equally so. The company that looks only at the near future is only digging its economic grave.

Looking at planning from an overall standpoint, it can either help a company or it can get the entire organization so snarled in red tape that you spend all of your time planning and none of your time doing. You look at all those beautiful charts and graphs — and you say, so what? Well, that's the key to the problem. **Planning is only as good as its execution.** You can plan until doomsday, but unless you take positive action of one sort or another, unless you **do** something, you are only running on a treadmill.

Planning can either be mental exercise or it can be a practical manifestation of an organization that is filing a flight plan with the intent of making the flight. If you don't get off the ground, you might as well forget it — and turn your reports over to some school of business administration to use as a laboratory study.

Not that planning should have a "nuts, screws, and bolts" flavor, but the recipe should be an extremely careful blending of those two priceless ingredients — imagination and horse-sense — with a strong dash of what might be called "action mindedness" thrown in.

How do you plan intelligently when technology is changing so rapidly that our entire emphasis is shifting from improving our techniques and our products to finding drastically new techniques and entirely new concepts in the broadest sense? Well, that is the $100 million question — **$100 million,** because plans made effectively today can become that large a business in a far shorter time than you think. My own company is a case in point. Only a very few years ago — 1946-1947 — television had not really emerged from the laboratories. Yes, there were sets, but only a thousand or two. Today, Sylvania's television business alone is far past the $100 million mark, yet Sylvania wasn't even in the television business eight or nine years ago, because there wasn't any. Technology is today changing at a rate which is frequently faster than the speed with which you can adjust for it. You all too frequently find yourself in the position of a duck hunter using a single-action, single-shot, BB gun.

Difficult as it may be, however, you can effectively plan research and development, and don't let your ivory tower boys tell you any different. Ever so often they like to tell you that R & D is filled with intangibles and cannot be measured the same as other areas of the company. It may be filled with intangibles, but it's not so intangible that you should regard it as a fleecy little cloud over your head.

One planning tool is the computer. As a device, or a machine, or an equipment, or whatever you choose to call it, the computer is the most compelling and far-reaching phenomenon to confront us for a long, long time. Although it cannot think, it certainly does extend the breadth of man's mind. It extends the skill of man's hands. It is the heart of national defense. But from our standpoint, the computer is most important because it will extend business planning to a degree of skill, speed, and effectiveness that has never been even remotely achieved to date.

In looking at computers, however, it is vital to our thinking that we keep in mind one extremely important point: It is not a question of what the computer will do better or faster. It is a question of doing things we have never been able to do before, or have never thought even existed before.

There is no doubt that great things are about to happen in the application of computers to commerce and industry — especially electronic data processing — the gathering and processing of information relating to accounting, marketing, production, and so on.

The more things we do with it, the more things we will learn we **can** do with it. As an example of what I mean, do you remember when the electron microscope was first introduced? It was the first electronic tool in the history of research. For the first time, the scientist would be able to magnify something 200,000 times. You know what happened. Certainly they saw many things better and more clearly than ever before. But they began to see things they had never seen before. This new tool caused science to change its basic thinking on many a subject.

That same phenomenon is occurring in the manufacturing side of the business, because of the greatly accelerated trend toward more and more automation. Several years ago, one of our plants, using standard accounting practice, used an overhead rate of about 140 per cent of direct labor. One day the last fully-automatic production machine was installed in one of the departments, and the last direct labor was transferred to another department. The cost accountant was stumped! What percentage overhead was he going to charge in a department that had no direct labor? After a certain amount of discussion, they decided to figure overhead on the actual units produced — which is the way they should have done in the first place. A change in basic thinking was forced by a new tool.

Long-range planning must be based on the principle that the human mind and human hands must be extended and strengthened. It is not a question of supplanting the human being; it is a question of giving man more help. That is your real planning job . . . the long-range planning job. Short-term planning, in the final analysis, is really only solving problems, relatively short-term problems. Planning in its true sense takes in the entire broad area of technology — computer, machine, and any other development whose potential influence is widespread. ★ ★

*Mr. Mitchell is chairman and president of Sylvania Electric Products Inc.

Digest of a paper presented before the Industrial Economics Conference, sponsored by Stanford Research Institute, Los Angeles, California, January 30, 1956.

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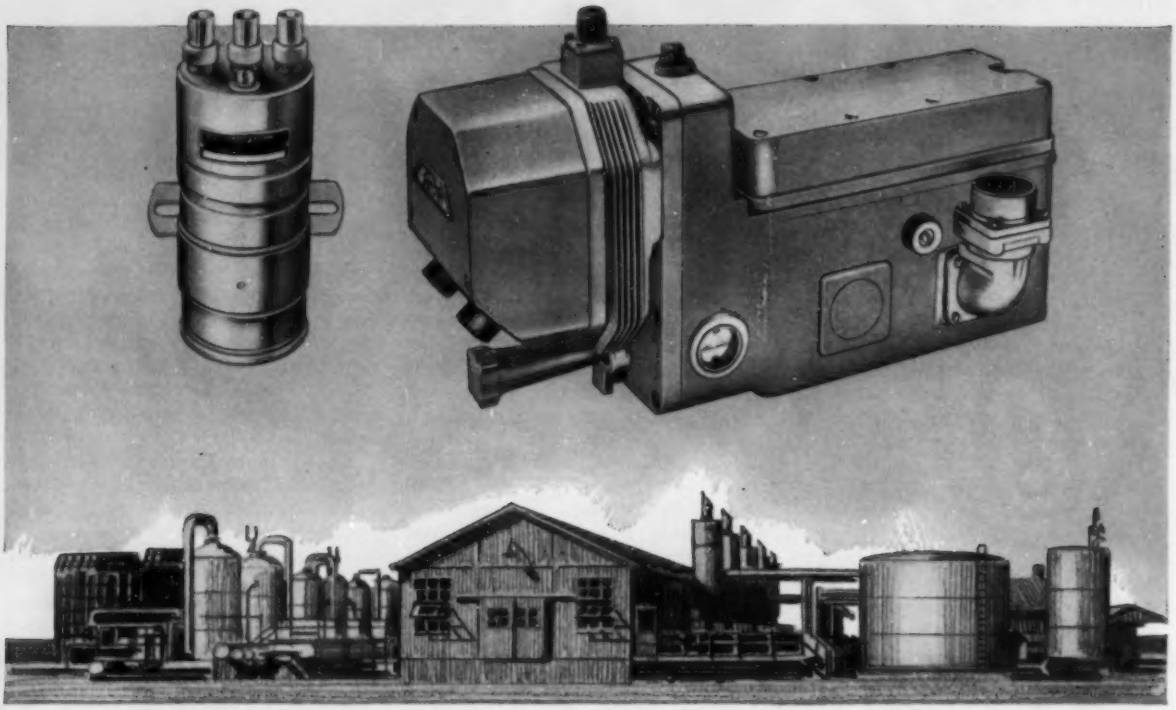

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When equipment is on the site new insurance problems must be met. Above is a materials store yard of a wildcat camp in Zulia State, Venezuela. Equipment requirements must be on hand at all times in remote areas.

When you operate abroad you are really going into the unknown insurance-wise . . . There is no easier way of losing time and money than to go unprepared.

Insure Your Foreign Operations

William F. Cushman

IF you are one of the many petroleum companies thinking of extending operations to foreign lands, some of these points may be of help in considering your insurance program. It does not matter in how many different states you may have operated here at home, you will soon recognize that any foreign country operation is a very different matter.

First of all, you will probably start by sending some important American personnel abroad to begin your initial investigations. From the moment you have such men moving abroad, be certain that your accident policies, your compensation covers, your fidelity bonds, your automobile policies and other covers provide for these foreign operations and remember that you will be operating beyond Uncle Sam's jurisdiction and under the laws and regulations of other governments.

These laws and regulations often are very different from ours and from each other, but are also usually accompanied by stiff penalties for violation. To insure compliance, there is usually an attractive reward to informers so that a substantial part of the penalty will be paid to anyone making known the violation of such laws. To make this more interesting, these laws and regulations are subject to frequent changes and in some countries are altered merely by decree, often retroactively.

Please keep in mind, too, that many

EXCLUSIVE

of these laws are in foreign languages and that abroad or at home, ignorance of a law is not an excuse for violation. Also, never underestimate nor minimize the importance of laws of other countries because when a foreign entity is involved, these laws can be very strictly applied.

Transportation

Once the investigative steps are over and the decision to proceed has been made, it is necessary to get equipment overseas to begin the exploration and drilling. Immediately, there arise new questions of insurance coverage. This valuable equipment must be shipped from some point in the United States (or even from some foreign country) to the site of the new projected operation. This means you must have adequate insurance from the original point to the port of overseas embarkation, thence by steamer to a foreign port and from there overland to the actual site of the operation overseas. Here it is important to keep in mind that the handling and transport of this equipment becomes a matter for serious consideration. You will find at some points that there will be little facility for handling heavy, valuable machinery. Experience shows that damage from such inexperienced handling can be serious and frequent where such poor port facilities exist.

Since there is this danger in transit over the various steps of the journey, it is wise to give careful consideration to spare parts and the ease and speed for replacement.

On the Site

Once the equipment is at the site and assembly can commence, new insurance problems are met with the new steps of the operation. You must remember that the site is undoubtedly remote from settled areas, usually difficult of access. The work of assembly will probably be under skilled artisans from the United States. In some cases, they will have crews also recruited from all over the United States. In others, they will have largely local workmen. Such a situation offers an interesting series of worker's compensation problems, which should be studied carefully to be certain that all insurance covers are in order and that the very best arrangements have been made.

Here, too, one should be certain how the physical properties are insured. Did the marine transit coverage extend only to the ocean port or did it carry on to the site? Did it perhaps carry on through the assembly operation? In any case, be certain that once the marine cover ceases that adequate permanent property damage insurance attaches.

During assembly, of course, one must recognize that the use of inexperienced local help may create many extra hazards both under compensation covers and possible physical damage policies, for experienced personnel have a knowledge that aids safety and cuts down losses.

The Author

William F. Cushman is assistant general manager of American Foreign Insurance Association. For many years he supervised AFIA's world-wide fire underwriting and is now in charge of AFIA's foreign operations. He has been with AFIA nearly 34 years, and is a graduate of Colby College. Member of the board of governors of the Austra'ian Trade Association, he has frequently served on panels of the Far East Council of Trade and Commerce and the National Foreign Trade Association. He travels extensively visiting AFIA's foreign branches, particularly through the Australasian areas, Europe and South America. At present, Cushman is on a trip to South Africa, Kenya, Egypt, Italy, Spain, France and the United Kingdom.

Local Perils

A further thought regarding physical hazards involves the location itself. Foreign operations must always recognize that certain areas are subject to perils such as earthquakes, windstorms of various types, riots and civil commotions, floods and similar occurrences. Often, one of these perils is far more serious than any of the hazards common to such risks in the United States.

Once the equipment is ready for use a new picture, insurance-wise, arises, for now the operation becomes more specialized. We must recognize that use of local workers may create different or more serious problems than use of experienced American workers. The unwillingness of the inexperienced to recognize danger that goes with use of exploratory and drilling equipment has caused more than one serious loss causing important delay to the operation, heavy physical damage to equipment, loss of life or injured workers.

Health Protection

Many areas where these oil activities are carried on (and today the world is well spotted with exploratory oil or drilling operations) hold life very cheaply. When a life is lost in the service of an American oil company, however, the price may be much higher, and very often the individual may suddenly have become a local celebrity with one or more wives, other relatives and dependents, all of whom must be considered in any financial settlements.

Hospital facilities may be distant. Perhaps even transport to hospitals in the United States may be necessary for American personnel. Careful thought before trouble can avoid many worries after a disaster.

Equipment Repairs

If an explosion or a fire occurs, can repairs be made on the spot promptly? Are spare parts available, or must they be brought in from the States? All this is important to the insurer as well as to the insured as it can involve serious and costly delay.

Valuation of rigs and other equipment is likely to be very different to the value at home. Is the insurance in accord with value at the site of operation? Since the equipment represents United States dollar investment, dollar insurance should be negotiated. There may be currency exchange restrictions making use of local currency impossible to obtain replacement of equipment. Some worker's compensation and liability covers may be advisable in local currency, some in dollars.

Insurance Must Be Tailor-Made

Every location and country offers its own unique insurance problem. Adequate insurance in all its phases is essential, but the oil companies have plenty of other problems in the actual oil operations themselves without having to study insurance laws, regulations, hazards, etc., in every country where they operate or contemplate operation. To insure adequate consideration of the insurance problems, their broker can consult the underwriters specializing in foreign insurance and together work out a tailored-to-measure program for the insured. In this way, the insurance can be arranged to cover every insurance need precisely as the specific case requires.

Transit, compensation, liability, motor car, property damage, equipment floaters—whatever the need—insurance can be made to fit the specific case as to coverage, currency and terms.

Apply to All Operations

These remarks deal mostly with the exploration and drilling operations, but apply equally to cracking plants under construction, to operating cracking and refinery risks, to storage depots or to tank farms.

The best advice in connection with a specialized field is to seek the assistance of specialists, and in this way, U. S. oil companies operating abroad can, with a minimum of time and effort, assure themselves of the proper protection for their investments and personnel. ★ ★

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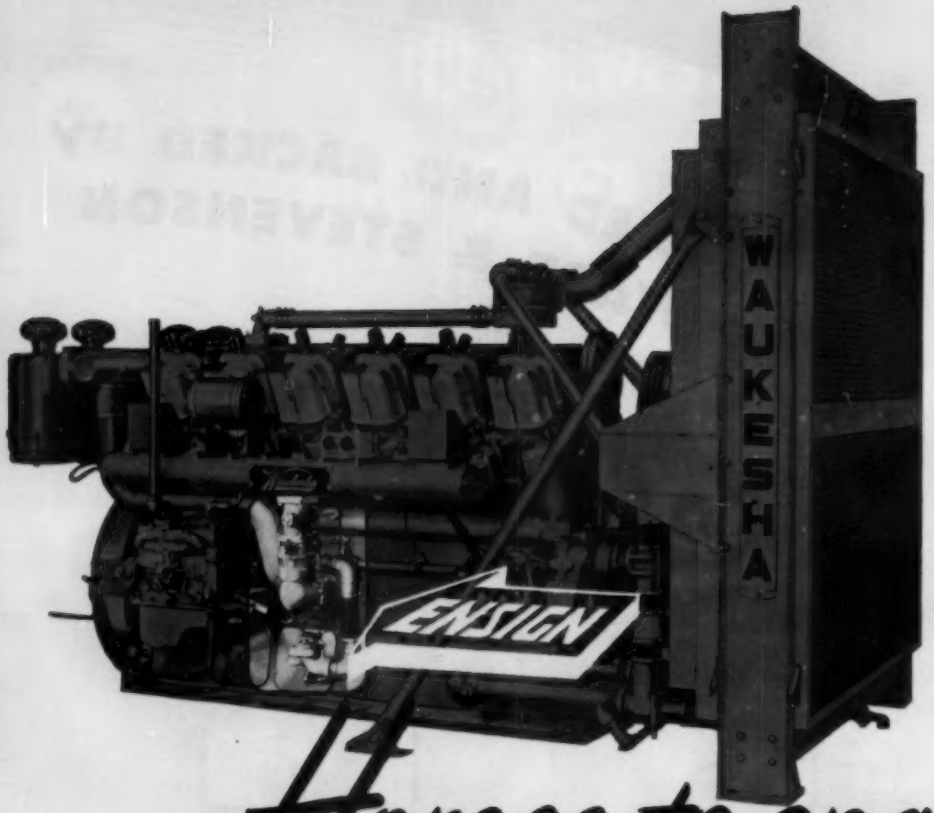

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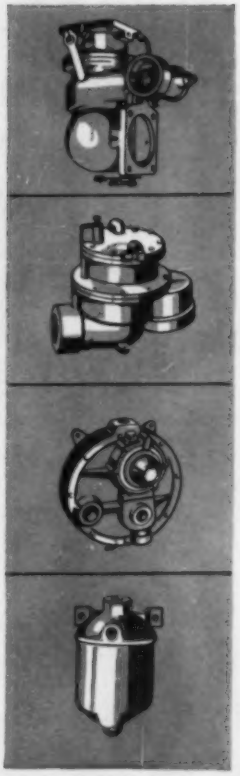

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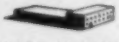

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Roadways of the World

F. A. C. Guepin

MAN'S progress through the ages — this march of civilization in which we are all so exhaustingly involved — has always been bound up with man's ability to develop communications, which are the channels of economic progress. From that primitive triumph, the invention of the wheel, we have indeed travelled far, though slowly at first.

There were nearly 2000 years between Julius Caesar and Napoleon, yet they both went to war at the same pace. In the 140 years since Waterloo we have progressed to all the modern marvels of transport by land, sea and air, but it is only in these last 20 years that science has carried us forward with such breathtaking speed. In this brief spell scientific developments have given us radar, television, supersonic flight, and bigger and faster road vehicles in ever-increasing numbers. Naturally such headlong progress has been of tremendous social and economic significance. But what has happened to road systems during these years?

The most striking economic fact about road development in the last 20 years is that it has failed to measure up to the needs of an expanding world economy.

It has failed in almost every country in the world to a greater or lesser degree and the full economic and social implications of this failure are striking. In the more developed countries it has resulted in waste — on a staggering scale — of national and industrial resources, and unnecessary discomfort to human beings. Everywhere it is restricting economic expansion, nullifying hard won increases in productivity and delaying improvement in the standard of living, which is the ultimate aim of all industrial and economic progress.

It is a failure which is daily becoming more critical. It is a sterilization of wealth which not even the richest of nations can afford. The total sums involved are astronomical, but here is simple illustration of what road delays can mean in terms of money.

Think of a road carrying 6000 vehicles a day. That means 250 per hour or 4 vehicles every minute — not a heavily travelled road. It has been calculated that a minute's delay every day on a road carrying this number of vehicles costs £7000 — approximately 12¼ million lire, 19,500 U.S. dollars, 7 million francs or 1 lakh of rupees — per year. A minute's delay! But we know that the delays on the roads of the world amount not to minutes but to thousands of hours and the total cost of this waste to both individuals and the national economy must be reckoned in hundreds if not thousands of millions of pounds.

Yet this situation is not irredeemable: if only the detailed plans that already exist for road development were taken in hand, the effect on world, national, industrial and individual prosperity would be immediate and stimulating. Who therefore stands condemned for this inertia?

The people first — for unless public opinion is roused, voiced and insisted upon, little gets done — and second, the Governments they elect — for they must be alive to the economic well-being and direct their national resources into the channels which will be most beneficial.

There is no doubt that roads do not get the attention and improvement the economy requires. Worse, in some countries they are being used indirectly to produce substantial general revenue by taxation on the road user — through heavy taxes on motor fuels and on the vehicles themselves. Although there may be arguments against a concept that all taxes collected from the road user be put into a special road fund, yet it must be unsound to regard road transport as a milch cow for general revenue.

Affects All Industry

Road transport is involved in every aspect of production and distribution. In the primary producing countries, foodstuffs, timber and minerals are, or could be, transported by road at some stage in the journey to the ports.

In the manufacturing countries the whole industrial process is organized on the assumption that the inward transport of raw materials and the outward transport of finished products will be a smooth flowing extension of the carefully organized processes which take place within our factories.

Unfortunately this is no longer a reasonable assumption.

Since the beginning of this century tremendous advances have been recorded in world production and trade; the disruption which the Second World War caused in this advance has generally been made good; and industrial production in the free world alone has roughly doubled since 1938. Energy production has risen by over 52 per cent since 1938.

The total motor vehicle population has more than doubled since 1938, from about 42 million to over 84 million today. Commercial vehicles alone have risen from about 7½ million in 1938 to about 18 million in 1954, an increase of about 2½ times.

And all of these increases must be borne by many roads that were not considered particularly adequate 20 years ago.

Good roads can undoubtedly bring some benefits through reductions in the cost of transport, some of which are:

1. **Saving of time through higher speeds and fewer stoppages, particularly in urban areas.**
2. **Saving of fuel through elimination of road congestion, although to some extent this may be offset as a result of higher speeds.**
3. **Less wear on tires.**
4. **Fewer accidents and consequently lower insurance costs.**
5. **Lower maintenance and repair costs through smoother flow of traffic on a better road surface.**

But without proper road systems we

This article is condensed from an address by Mr. Guepin, "The Financial and Social Aspects of Road Development," given before the world meeting of International Road Federation in Rome, October 1955.

cannot make use of even half the speed and power which the ingenuity of the automobile industry has made available. It provides trucks capable of cruising at 40 mph — but manufacturers must be satisfied, even pleased, with an average operational speed of 15-20 mph. It provides an average brake horsepower in American cars of 195 — but the average speed in American cities has been given as 4½ miles an hour and is still falling. In London, the bus takes longer than its horse-drawn predecessor. In other words, although man has succeeded in flying at 1200 mph, he has been reduced to travelling to work at little more than walking pace.

If road development continues to lag behind the increase in vehicle population, congestion will increase to the point of stagnation, road transport costs will become prohibitive and our brilliantly technical and complex modern economy will be choked to death.

There can surely be no doubt that improved roads bring increased national prosperity. How, then, can we ensure that enough of the world's resources will be spent on roads?

In recent years roads generally have not received their just share of the national cake. The relationship between national income and national expenditure on roads clearly shows that the expenditure has been much too low.

The countries which between them account for 90 per cent of the total vehicles in the world and 75 per cent of the highway mileage, spent only 1 per cent of their national income on roads in 1948 during the aftermath of the war, but, despite the enormous increase in traffic since then, the percentage in 1953 was only 1.3 per cent — the sort of inadequate sum which might take care of running repairs but no more. This is a patchwork approach to the problem. This is expenditure not investment.

Although there is immediate need for action, some things are being done in the world to achieve improvements, and here are a few results:

In **Holland,** the yearly benefit to traffic of new roads proved to be several times their yearly costs, including interest and depreciation of initial construction capital, together with maintenance charges. These new roads are "paid off" in 5 to 10 years — a fine return for any investment.

Again, in **Belgium** savings included a 50 per cent reduction in tire wear, a 10 per cent savings in wages of driving personnel, a 25 per cent fall in accidents and insurance costs, and a reduction of around 10 per cent in fuel.

Western Germany has clearly proved the value of "motorways" or autostradas, and an average saving in time of 33⅓ per cent has been claimed over the old road system, while even higher figures have been recorded. It is also claimed that accidents have been reduced on these new roads by 80 per cent. But perhaps the most striking figures are those relating to wear and tear on both vehicles and drivers.

Tests showed: Gear changes numbered 102 on an old road to 4 on a new one; brake applications were 491 compared with 3.

In **Turkey** about 80 per cent of the population depend on agriculture for a livelihood, and the inability to market their produce held back the country to a system of primitive subsistence farming. It is only in recent years that the many isolated communities have begun to be linked up by a road network. Since 1948 some 20,000 kilometers of road have been built or improved, and this has been largely instrumental in bringing nearly 3 million acres of hitherto idle land into cultivation.

In **New Zealand** the striking development in primary production during the past three decades is mainly the result of the improvement in road transport. Without roads the great development of the dairy industry could not have taken place.

Finally, to prove that small projects can show big savings, here is an example from the heart of London. At a busy intersection in Kingsway, about 50 meters of footpath was cut back at a corner to widen the road by a maximum of 1 meter. The cost of this minor work was £3530 and the **annual** saving no less than £1815 — a return of 50 per cent per annum on the investment.

The Author

Since joining the Royal Dutch/Shell Group of oil companies in 1929, F. A. C. Guepin has dealt with group operations in various European markets and in the United States.

From 1937-1944 he held numerous management posts in the United States, and in 1940 was appointed senior vice president of the Shell Union Corporation (now the Shell Oil Company.)

He returned to London in 1944 and in 1950 was appointed a Managing Director of the Royal Dutch Petroleum Company and other companies of the Royal Dutch/Shell Group. He is also chairman of Shell Chemical Corporation. He serves as vice chairman of the International Road Federation.

In 1947 Queen Wilhelmina made him an Officer in the Order of Oranje Nassau. Mr. Guepin is also an officer of the Legion d'Honneur. He was born and educated in the Netherlands.

Social Aspects

There is also the social aspects of roads. Do you sometimes pause to consider the very profound influence of road transport on the individual? On your own life; in your employment, travel and creature comforts? Perhaps even on your own personality?

From the earliest times transport was for long an individual affair. Man first walked, then rode a horse or was drawn by one until, with the advent of the steam engine, an era of public transport came in. Each era will be seen by historians to have its different social patterns, but today even we can see our pattern changing, this time back to individual transport with cars, motor cycles, scooters and autocycles.

Man is a gregarious creature and does not like living in isolation. Roads and modern transport are completely transforming rural life in all the remote areas. Farmers can now easily obtain their equipment, fertilizers, seeds and other necessities, and can send their produce rapidly and fresh to market.

Rural communities can enjoy the advantages previously available only to urban dwellers; they are no longer cut off from the benefits of adequate health services, and children can receive a better education in centrally sited and better equipped schools.

In maintaining full employment, roads and road transport are a major factor. It has been estimated that in the **U.S.A.** about one person in seven earns his living from employment connected with roads. In **France,** where the figure is one in eighteen, it is the largest single provider of employment.

The employee no longer needs to live close to his work in crowded urban districts, and industries themselves can more easily be decentralized.

Much could be said about the psychological benefits man derives from the ownership of individual transport, and his ability to travel at will in his leisure hours. Individual visits to neighboring countries, which can best be seen by road, bring the different nationalities into contact with one another, and may help promote understanding between peoples and further the cause of peace.

There is much more that could be said and the whole subject opens up fascinating vistas, but let us not for a second lose sight of our target, which is to get the present chaos put right and to ensure that the future developments are planned with imagination and vision, to obtain the best results.

Remember, that you pay for good roads whether you have them or not, but you pay more for them if you do not have them. ★ ★ ★

Fifth of a Series

Communication:

How Is Your Telephone Personality?

Dennis Murphy*

AFTER Alexander Graham Bell sent the first sentence over an electric wire on March 10, 1876, some means of intercommunications was needed. So, the world's first switchboard was opened two years later in New Haven, Connecticut. It was operated by a boy; in fact, young men operated all of the early switchboards in other towns. But these boys were often rowdy, impolite, and indifferent; therefore, the first woman operator was hired in 1879. With her began our traditional "voice with a smile" — a voice that means courteous and friendly service.

Today, the Bell System, with a score of subsidiaries, provides foreign and nation-wide telephone service. Each day it takes care of about 200,000,000 calls by means of 52,000,000 telephones and 650,000 employees who are courteous. Top men in this company, too, insist on answering their telephones when they can.

Your Telephone Manners Reflect You

Are the telephone answers in your company building better public relations? Are they a good advertisement for your firm? In New York alone over 1500 manufacturers, hotels, banks, and stores, employ skilled advisors who "listen in" on regular calls. These experts overhaul the telephone habits of employees who bang receivers, speak curtly, transfer calls impolitely, carry on side-conversation during a call, and drive many customers away with bad manners. Thoughtlessly they hurt business.

Making sales appointments that get through to the prospective buyer requires telephone tact. And making a friendly ally of the secretary or the receptionist to a top executive always helps; indeed, no salesman can afford to scold, arouse suspicion, or ride roughshod over anyone. Honestly asking for her help and "dropping your problem into the secretary's lap" is a far better technique.

Shakespeare had Hamlet advise his court players this way: "Speak the speech, I pray you, as I pronounced it to you, trippingly on the tongue." He wanted each word so clear and distinct that neither his uncle nor his mother could possibly misunderstand a syllable. And since the telephone isn't a high-fidelity instrument, **Smith** may sound like **Fish** — if you slur or chew or mumble your words. Or rattle off words too rapidly.

*Administrative Assistant, Service Pipe Line Company, Tulsa, Oklahoma.

Six Tips That May Help

Each telephone voice leaves two impressions: one of the person speaking and one of the company represented. **What you say** and **how you say it** are highly important in creating good will toward your company and in building your own reputation as an employee. Each company may have telephone policies of its own. So ask your supervisor about policies for your department.

I. Answer the Telephone Promptly, Talk Clearly, and Always Be Courteous

Put a friendly smile in your voice! Attitude toward your work shows up in your voice. A good telephone voice is low-pitched, pleasingly confident, cordial, and — alive! Nothing sounds worse than the dead-pan voice of an uninterested employee. Nasality and mannerisms are taboo.

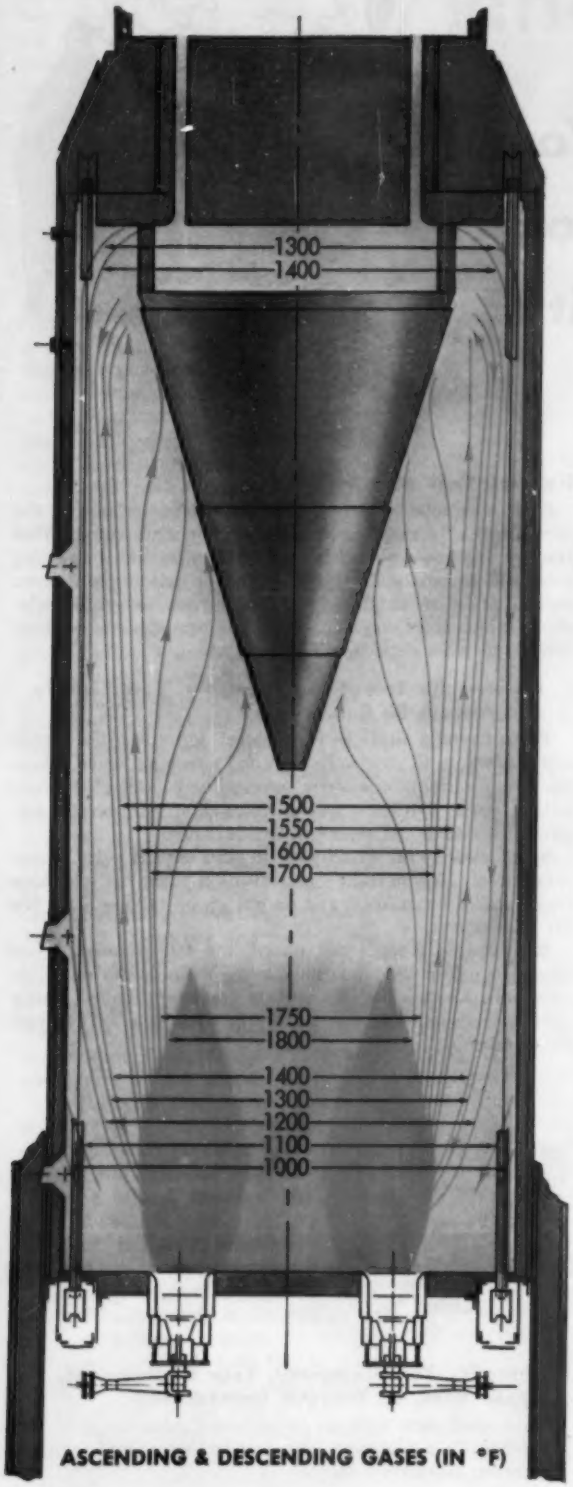
Speak close to the mouthpiece in your natural voice. Enunciate clearly. If you're in a conversation when the telephone rings, ask to be excused and do not go on talking after you lift the receiver.

Be prepared. Keep a pad, pencil, and data frequently used close at hand so you won't have to dig them up during a conversation. Keep a list of numbers frequently called. Long-distance calls take twice as much time when you don't furnish the number.

II. Identify Your Company, Your Department, Your Boss, or Yourself Immediately

In a small firm with no switchboard, identify your company first. In a company with a switchboard and many departments, you have a choice:

PETROCHEM-ISOFLOW FURNACES



ASCENDING & DESCENDING GASES (IN °F)

Here are the facts!

The first vertical cylindrical heaters provided even circumferential heat input, but vertical flux distribution varied considerably, from high transfer at the bottom of the tubes to low rates at the top. Improvements in design during the past twenty years have overcome this difficulty, by providing proper firebox proportions, a reradiating cone, and burners specifically designed to the requirements of the furnace.

It is significant that *only Petrochem-Isoflow furnaces* incorporate all three of these critical items of design.

The small, hot cone tip reradiates to the tubes, across a considerable distance. Because of the conical shape employed, each higher element of the cone is of larger area, and closer to the tubes than the section below. These factors compensate for decrease in cone temperature from tip to base, provide relatively constant radiant heat transfer over entire upper tube length.

The cone also serves to divert flue gases along the upper ends of tubes, which adds convection heat transfer over this length. It also initiates a high rate of firebox recirculation of combustion products, by cooling the gases in their passage across the tubes.

Being cooler, and therefore heavier than the rising gases in the center of the firebox, the gases adjacent to the tubes fall to the bottom of the heater by thermal siphon effect, increasing the heat input to the rear of the heating elements by convection. The descending gases also serve as a buffer between hot gases and the lower ends of the tubes and dilute the products of combustion. The special burners, by developing a symmetrical flame pattern, contribute to the equality of heat distribution over the entire radiant tube length.

Of the design features mentioned above, the cone is of the greatest significance because it is essential to even radiant heat distribution.

Experienced operators know that even heat distribution improves product quality, decreases tube deteriorations, results in longer, trouble-free operating cycles.

The Data Shown in the Drawings are ACTUAL PERFORMANCE RECORDS!

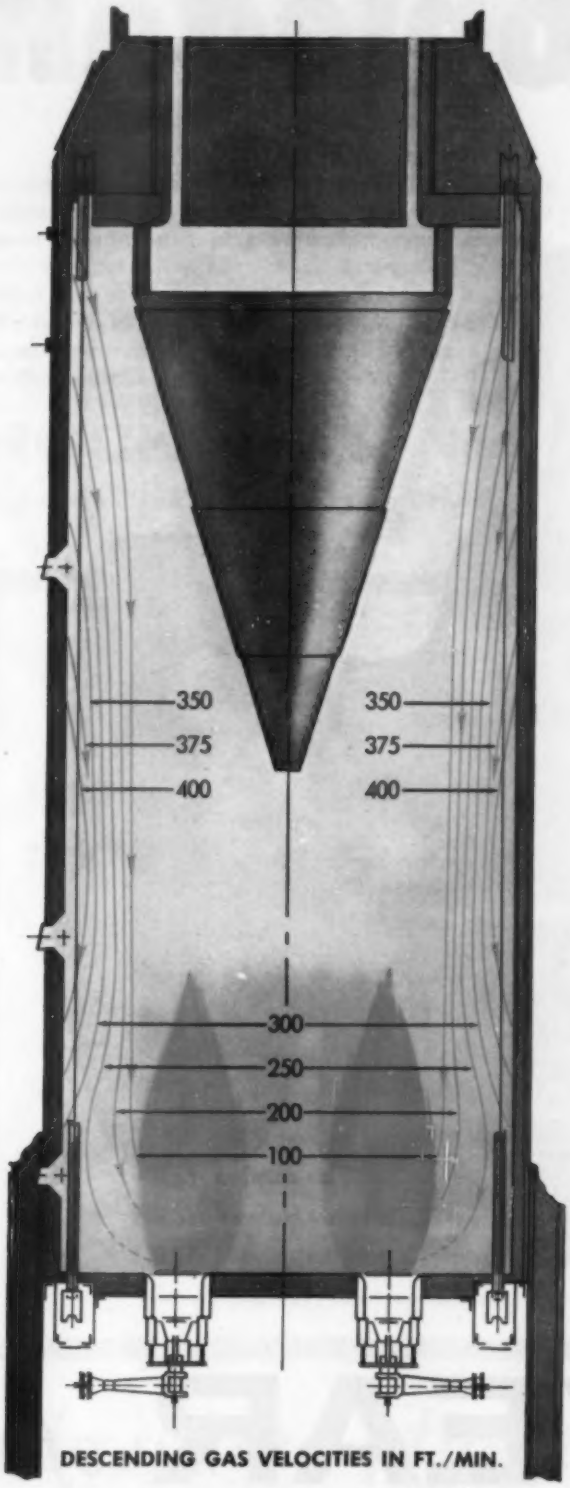
To check radiant flux distribution in Petro-Chem furnaces, exhaustive tests were made under actual operating conditions; some of the results of these tests are indicated in the two adjacent drawings.

Left: Plot of isotherms in a Petrochem-Isoflow firebox, illustrating the uniformity of firebox temperature.

Right: Plot of flue gas flow patterns and velocities, demonstrating the high gas recirculation rates.

Both of these phenomena are the result of proper firebox proportions, the two-fold action of the cone, and symmetrical flame pattern.

Provide EVEN HEAT Distribution !



DESCENDING GAS VELOCITIES IN FT./MIN.

In addition to even heat distribution, other all-important factors which determine the value and efficiency of processing furnaces include:

MAXIMUM FUEL EFFICIENCY
PLENUM CHAMBERS FOR HAZARDOUS AREAS
SIMPLICITY OF DESIGN AND CONSTRUCTION
EXCESS DRAFT FOR HIGH OVERLOAD
EXPLOSION RESISTANT
MINIMUM GROUND SPACE
SHORT LENGTH OF LIQUID TRAVEL
ZERO AIR LEAKAGE
LOW PRESSURE DROP
LOW MAINTENANCE

In every case where these 11 all-important design characteristics were employed to compare one type of furnace design with another, PETROCHEM-ISOFLOW FURNACES were proved more economically desirable by any comparison.

More than 1350 Petrochem-Isoflow Furnaces have been installed since 1940—an unequalled record of acceptance based on proved performance.

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—ISOFLOW FURNACES

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Nordstrom VALVES

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Rockwell-Nordstrom is the *original* lubricated plug valve. But that is only part of the story behind forty years of lubricated plug valve leadership. Starting with the first valve, *every major development* in lubricated plug valves has come to you *first* in a Rockwell-Nordstrom valve. Today, as always, the *oldest* lubricated plug valve is also the *newest* in terms of better performance, longer life and lower cost.

Below are listed only a few of the more than ninety basic Rockwell-Nordstrom valve and lubricant innovations. They are the reasons why Rockwell-Nordstrom valves—although often copied—have *never* been equaled. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

Canadian Valve Licensee: Peacock Brothers Limited

ROCKWELL-Nordstrom VALVES

Lubricant Sealed for Positive Shut-off

first...for forty years *Here are just a few of more than ninety basic valve and lubricant innovations that have maintained the leadership of Rockwell-Nordstrom valves—through better performance, longer life and lower cost.*

- **FIRST Lubricated Plug Valve**
- **FIRST Sealdport* pressurized lubricant sealing**
- **FIRST Hydraulic plug jacking for fast, dependable operation**
- **FIRST Hypreseal* for high pressure plug valve service (still exclusive)**
- **FIRST Special plug and body coatings—longer life on "tough" services**
- **FIRST Automatic shut-off valves for gas pipelines**
- **FIRST "Self-Energizing" valve lubricants**
- **FIRST Line of special and general purpose valve lubricants**
- **FIRST Multiport lubricated plug valves for 3-way and 4-way flow control**
- **FIRST Lubricated plug valve for low temperature service**
- **FIRST Venturi valve for lower cost on larger lines**
- **FIRST Lubricated plug Christmas tree valves**

*Registered trade mark Rockwell Manufacturing Company

lubricated plug valve leadership

"This is the Traffic Department." or "This is Mr. Black's office."

"Traffic Department, Jack Young speaking," Most men drop the use of **Mr.**

"Traffic, Mary Brown speaking," or "Traffic Department, Miss Brown speaking."

"Traffic, Young." This shortest form, if spoken with care, saves time.

Some consider the word **speaking** redundant, but it means **representing** and is necessary with some names.

DON'T CARRY ON A PRIVATE CONVERSATION LONGER THAN THREE MINUTES ON YOUR BUSINESS TELEPHONE — or you may block, delay, or lose business.

Avoid **Hello, Yeah, Yep, Un-huh** (yes), **Unh-unh** (no), **Hi-ya, all righty,** and other chummy but unbusinesslike words. Degree of acquaintance rules here.

III. Tactfully Try to Find Out Who Is Calling, Unless You Are Instructed Not To

This requires grace. Right phrasing of words and inflection of voice will usually get a willing answer. Polite persons identify themseles at once.

Don't say —	**Say —**
Who's calling?	May I tell him who is calling, please?
Who is this?	Please may I take a message for him?
What's your name?	Do you wish to leave any message?
Who are you anyway?	Would you like to have him call you, sir?

IV. Use Tact in Giving Out Information About Your Employer and Your Work

The word **secretary** means "one who guards secret information of the boss." This involves neither deceit nor falsehood, but discretion and loyalty.

Don't say —	**Say —**
He hasn't arrived at the office yet.	He's not in the office just now, but may I help you?
He's never come back from lunch yet.	He's not in, but I'll be glad to take a message.
He's in the coffee lounge.	He just stepped out of the office.
He's calling Chicago on long distance.	He's busy right now. Or, He's on another phone at the moment.
He flew to Washington on Monday but won't be be back until tomorrow.	He's out of town, but will be in the office tomorrow. May I help you?
He and his wife drove to New Orleans.	He's out of town this week.
He went to the Elks' Dance and isn't able to attend anything today!	He has asked me to say it's impossible for him to attend the meeting today.

V. Try to Be Helpful Whenever You Can. Service Is Our Greatest Product!

Never make a caller wait indefinitely. Ask whether he prefers to hold the line, to leave a message, or to call (or be called) later. If your boss is out of the office, ask whether you should try to get in touch with him.

When you need to look up information that may require several minutes, tell what you are going to do. Ask for permission to call him back.

Never transfer a call that you can attend to rightfully. **Nobody likes to repeat his message over and over to several different persons before finding one who can attend to it.** And if you give him the run-around, he suspects both you and your company of inefficiency.

If you are unable to help, courteously say: "That is something Mr. Doe in our Accounting Department looks after. If you wish, I'll tell him about it, and I'm sure that he'll give it prompt attention."

If your company has a switchboard, ask if he would like for you to transfer his call to the proper person. Then do it quietly, gently.

Don't say, "Transfer this to Doe," but courteously say, "Please transfer Mr. Blank to Mr. Doe."

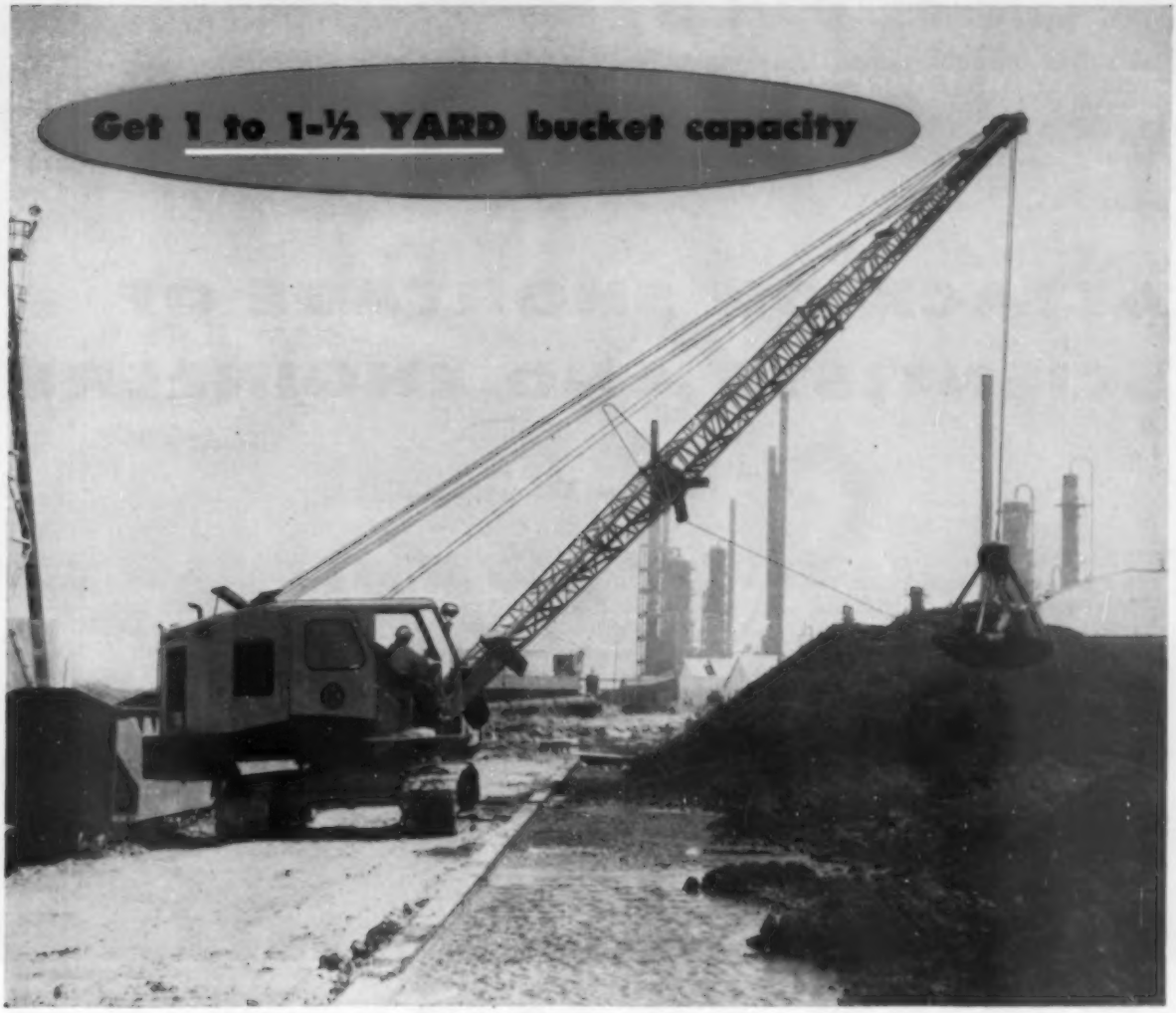
VI. Try to Make Telephone Communication Easy and Pleasant in Business

Try hard to let nothing upset you, fluster you, irritate you. Stay happy! Accentuate the positive; eliminate the negative. Don't say "He isn't in." Say "He's attending a meeting. May I have him call you when he returns?"

Let your guest say goodbye and leave before you close the telephone door. And never slam the door — replace your receiver gently. **Try to make your caller leave happy.** Yes, always keep that friendly smile in your voice.

If your organization is large, your telephone company may send one of its customer service advisors to meet with your employees and demonstrate the best techniques of telephoning.

* * *



20-TON lift capacity with Koehring 405 crane

Take another look at the heavy-duty crane shown here. It's the new 405 — latest addition to the Koehring line — and brings you a big advantage in *extra work capacity*. For example — with one of these 405's you're equipped to lift any load up to 20 tons. Boom lengths range from 40 to 90 feet. For added reach, 15 to 30-foot jib can be used on any length boom up to 80 feet. This gives you a maximum boom and jib of 110 feet.

Extra lift capacity and stability as a crane increases the Koehring 405's *work capacity* with all attachments. It handles 1 to 1½ yard clamshell or dragline buckets on a wide work radius — readily converts to 1-yard shovel or hoe. Here are some of the heavy-duty features that help you get more work done with every attachment: Big power clutch requires only 1/10th the lever pull of a comparative-size manual clutch — yet retains accurate "feel" of load. Automatic traction brakes also simplify operation — are engaged at all times, except when tructive power is applied — lock and hold the 405 when working or parked. Maintenance is simplified, too. There are only 2 main shafts in the 405's upper machinery. Each assembly is an independent unit with fully enclosed gears, and splined shafts rotating on anti-friction bearings. For more complete details, see Koehring distributor, or write for bulletin.

mail to:

KOEHRING Co., 3026 W. Concordia, Milwaukee, 16, Wis.

Send us ☐ spec. sheets ☐ bulletin on Koehring 405.

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Need for more scientists and engineers has brought action from many petroleum companies . . .

Here is how the Shell organization has made its . . .

ATTACK ON SHORTAGE OF SCIENTISTS AND ENGINEERS

Ernestine Adams*

EVERYONE seems to agree that there is a shortage of scientists and engineers, from the young graduate who is commanding a salary his father worked 10 to 20 years to get, to the key leaders in The National Science Foundation.

In the United States the Government doesn't put its finger on thousands of bright young men and women and say "You take a course in engineering." Using persuasion and awakening interest are the recourses for a democratic nation.

Business and industry have in this instance taken a leading part in promoting education of more scientists and engineers. The petroleum industry scores high in this endeavor.

A new approach has been worked out by Shell Companies Foundation, Incorporated, in conjunction with two universities — Stanford University, Stanford, California and Cornell University, Ithaca, New York. The experiment will be watched with interest by other foundations and a procedure will be set up to determine results of the project.

For High School Teachers

Called the Shell Merit Fellowship Program, the purpose is to acquaint high school science and mathematics teachers with recent developments in the basic and applied sciences including mathematics and with effective methods of instruction.

The idea is that young people commonly decide their career before entering college and their decisions are based on what interests and inspires them in their preparatory work. They can be better qualified also, to go on to science and engineering courses, which are considered more difficult subjects than some others. It is believed that the shortage problem can in large part be solved through superior instruction at elementary and secondary school levels, which will stimulate more young people to enter the science and mathematics fields.

Another factor not often mentioned is that there is a great deal of competition among businesses for outstanding students. Bankers, for instance, are pleading for more young people to go into business administration to supply the need for more executive material in financial circles. The crux of the matter probably, is that a much larger proportion of students should be persuaded to enter upon and spend more time and effort in higher education.

In the Shell Merit Fellowships, high school teachers — both men and women — of chemistry, physics and mathematics who have taught at least one of these subjects a minimum of 5 years and who hold at least a bachelor's degree are eligible.

60 Scholarships Available

Sixty fellowships are available each year; 30 for teachers living west of the Mississippi for study at Stanford and 30 for those on the east side for study at Cornell.

Philip G. Johnson, coordinator of the program at Cornell, says that by the middle of February 1118 inquiries had been received there and 280 applications had been completed. Paul DeH. Hurd, Stanford's coordinator, reports 700 teachers have requested applications since the announcement of the Shell program.

The response seems extremely high and indicates a willingness and desire on the part of these teachers to find ways to improve teaching in their school, school system and state.

Committees at each university have the difficult job of selecting the 30 awardees. Those not named this year may re-apply in future years.

The awards cover tuition, fees, board and lodging in university facilities; a transportation allowance, and a stipend of $500 to compensate in part for lost summer earnings.

Summer Programs

At Stanford, Dr. Hurd lists these three phases of the summer program (June 25 to August 21):

1. Acquaint each participant with the most recent theoretical developments within histeachingfield.
2. Through the use of 30-35 scientists, engineers, and mathematicians, selected from industry and research laboratories, to acquaint each teacher with the latest applications of theory to scientific and industrial developments.
3. In a specially developed professional course an opportunity will be provided for each teacher to learn about improved instructional methods and teaching resources.

Both schools are approaching the program on a seminar basis — using discussion periods, laboratory experiences, visits to research and production establishments.

Dr. Johnson adds "One further idea is the value of constant and continued evaluation with a willingness to make changes in plans and procedures. This spirit will be fostered by the early selection of an evaluation committee to counsel with the staff on needed improvements. Then there will be a careful evaluation by all participants of the 1956 program together with suggestions for the future. The willingness of the staff to have their efforts evaluated by the high school teachers is an indi-

*Management Editor.

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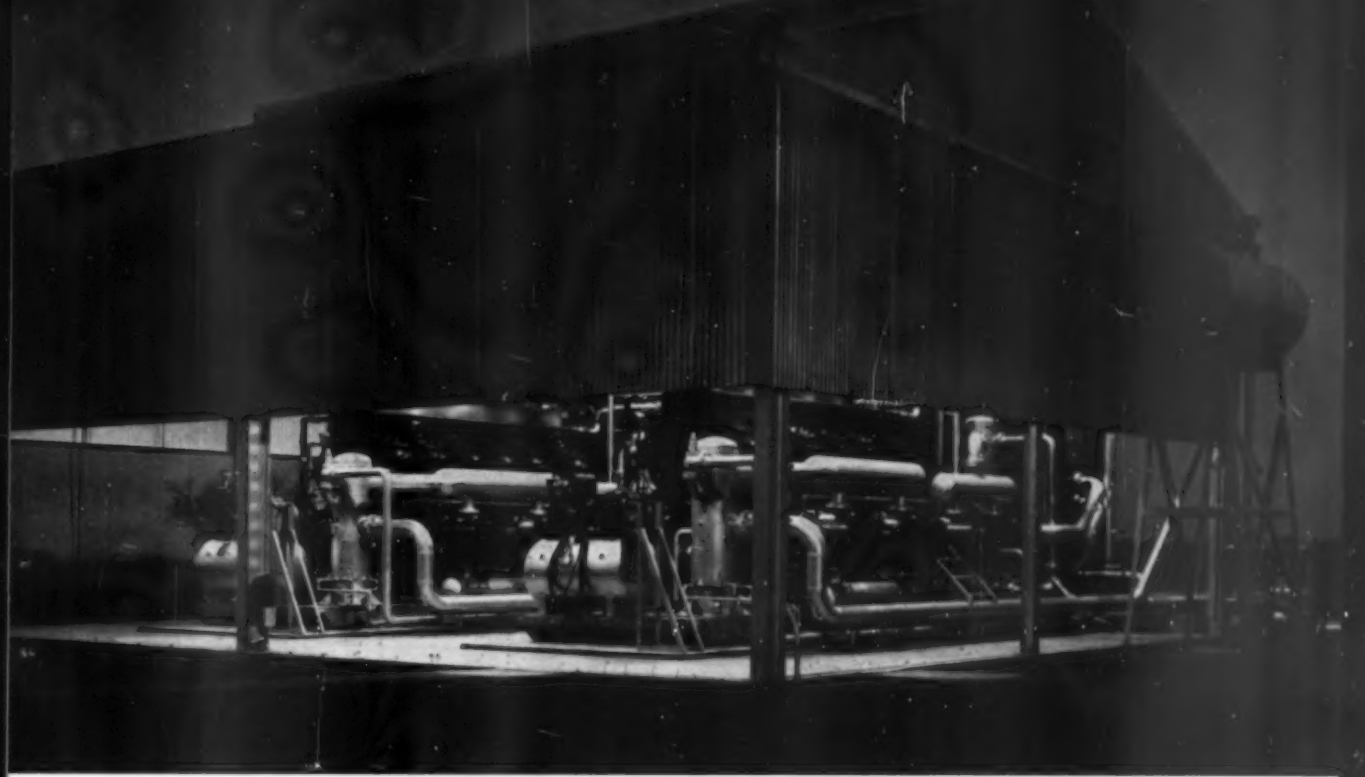

HOUSTON NATURAL GAS CORPORATION ODEM FIELD COMPRESSOR STATION—equipped with two Beaird-Ingersoll-Rand 660 h.p. 12SVG four cycle gas engine driven compressors, Young radiators, lubricating oil coolers and gas coolers, and all necessary controls. Other sizes 110 to 660 h.p.

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Houston Natural Gas Corporation built this compressor station in Odem Field, Texas, to boost natural gas to lines serving the expanding Corpus Christi area. Equipped with two 660 h.p. Beaird-Ingersoll-Rand 12SVG packaged units, it is capable of handling 12 mmcfd. Utilizing packaged compressors minimized field assembly and added needed reserves at a saving in both time and cost of installation.

Operating with two stages of compression, the units pick up gas from nearby wells at 50 psig. and boost it to the line at 325 psig. Automatic controls built into the compressors prevent suction pressures from being pulled below 50 psig. required for efficient operation of the separators. Flexible in design, the units can be converted to three-stage compression to follow the pressure on down as the field grows older. When reserves are depleted the compressors can be moved to other service and nearly all of the present installation salvaged for re-use at the new location.

Let us show you how complete packaging simplifies installation and reduces field assembly costs.

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3. Overload Capacity... 1500 watt continuous duty with generous overload capacity prevents tool stalling under heavy loads... insures uninterrupted service even when starting loads exceed operating loads.

4. Compact and Lightweight... one man can easily carry this 90-lb. generator wherever you need electricity to power time-saving electric tools. No need for long, hazardous power-consuming cables.

Whatever tools you want to operate—electric saws, drills, floodlights, grinders, belt sanders, hammers,—the new Homelite 35A115 generator can save you money. For a free demonstration or additional information, call your nearest Homelite representative, or write:

SAVE EVEN MORE! New Homelite idle control unit, available as optional accessory, runs engine at idle speed when no current is drawn... automatically brings engine to full speed when load is applied.... Ask your Homelite representative to show you how this easily-installed accessory reduces engine wear... increases service life... cuts fuel consumption.

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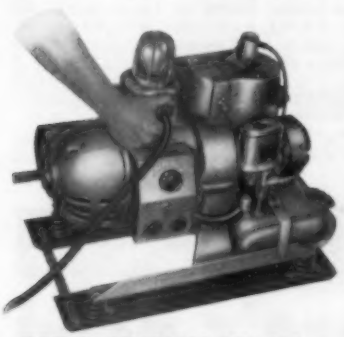

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cation of the eagerness with which the staff is seeking ways to improve secondary school work in mathematics and science."

Evaluation Program

As a follow-up, recipients will be encouraged to supply certain data to the universities for a period of several years in order that a long range evaluation of the program itself can be made.

After the intensive summer study and the stimulation of ideas gained in courses, discussions with special lecturers and with other teachers, it is expected that the teacher will return and assume the leadership essential to the development of improved science and mathematics programs in his school and to encourage students to choose careers related to science and mathematics.

Dr. Hurd calls it "a basic attack on the critical shortage of scientists, engineers, and mathematicians.

"If we are to have more scientists, engineers, mathematicians, and also teachers in these fields," he says, "then we must increase the numbers who choose to specialize in these areas rather than competing for the limited number who are already trained. This is a long term look at the shortage problem."

Objectives Defined

Six reasons are given by Dr. Johnson for believing the Shell Merit Fellowship will be an outstanding service:

1. Competent teachers with high leadership potential are willing to attend and share their ideas.
2. Some outstanding supervisors will have a chance to give as well as take help from teachers and staff.
3. There will be genuine concern about problems of teaching as well as about the subjects and their application.
4. Mathematics and science teachers will seek ways to assist each other.
5. There will be a willingness to evaluate all services and to seek improvements.
6. Judgments of many persons will be considered in developing plans for 1957.

It is good to know that the problem of shortages in trained engineers and scientists is being attacked on many sides and from many angles. It gives us new pride and confidence in our industry that so many companies are diligently seeking ways to arouse interest and effort toward overcoming the problem. ★ ★ ★

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BOOKS ★

Drilling Records for Oil and Gas in Utah, *Bulletin 50, compiled under the direction of George H. Hansen and H. C. Scoville for the Utah Geological and Mineralogical Survey, College of Mines and Mineral Industries, University of Utah, Salt Lake City, Utah. Pages, 116. Price, $5.00.*

Exploration for oil and gas, notes on significant drilling during 1954, as well as a tabular summary of oil wells drilled in Utah before 1954 and 29 individual county maps have been included in this bulletin. It was originally planned to include the subject matter of this book in a symposium volume, but because of the large demand for drilling records and increasing number of these wells and associated data, this idea was abandoned. The result is a highly comprehensive, well cataloged key to drilling data, past and present, for the state of Utah.

Petroleum Production Engineering, Oil Field Development, *by Lester Charles Uren, published by McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, New York. Pages, 792. Price, $12.00.*

Since many important advances have been made in petroleum production technology and improved methods and equipment developed since the last edition, this fourth edition has been prepared to adequately reflect the present state of development in this field. In addition, the author has attempted to reflect in this volume the recent trends in petroleum engineering of placing this professional field on a more quantitative basis.

Primarily designed as a textbook for engineering students, the book may also serve as a guide to the literature of the field. Hence, a selected and classified bibliography is appended to the end of each chapter. Following the same general format as earlier editions, the revision permitted insertion of new material, 58 new illustrations, completely rewritten sections, and the opportunity to better express the changing emphasis on different phases. The author suggests that while complete in itself, this volume is to be regarded as one of three closely related volumes. The others: **Oil Field Exploitation,** third edition, and **Oil Field Economics.**

Filtration Manual for Product Designers, *published by Purolator Products, Inc., Department FM, Rahway, New Jersey, Price, 25 cents.*

A new comprehensive manual of filtration especially written for product designers is available describing numerous filter applications and deals with such design considerations as flow rates, viscosities of fluids, and contamination to be removed, as well as filter costs, space requirements of the designer, types of filter elements and the proper selection of elements. A complete glossary of filtration terms is also included in the manual which contains numerous illustrations and charts.

Proceedings of the Second Annual West Texas Oil Lifting Short Course, *published by The Department of Petroleum Engineering, Texas Technological College, Lubbock, Texas. Pages, 96. Price, $3.50.*

Thirty papers presented at the second annual course, April 21-22, 1955, in Lubbock, Texas, have been bound together for a very comprehensive and extensive store of current information and developments in the field of oil production. Full text of the papers is given, complete with illustrations, graphs, photographs and tables. Subject matter varies from v-belt drives to care of treaters.

The West Texas short course drew over 300 people representing 100 companies from seven states.

Taxation of Oil and Gas Income, *by Clark W. Breeding and A. Gordon Burton, published by Prentice-Hall, Inc., 70 Fifth Avenue, New York, New York. Pages, 340. Price, $12.00.*

Designed as a guide to the person who plans the transactions of oil and gas producers, so that tax impact can be predicted with reasonable certainty, this book sets forth the income taxation principles that control such transactions.

It offers practical guidance in solving the daily tax problems of oil and gas production, plus assistance in prevention of overpayment of taxes and procedural error under the 1954 Internal Revenue Code. Complete with authoritative explanations of I.R.C. changes, this book shows how to minimize the tax consequences of every transaction from the conveyance of property rights, through joint operation set-ups, to the sale of gas and oil at the wellhead.

Although primarily concerned with operations of the industry in the United States, one chapter has been devoted to the corresponding tax concepts applicable to practice in Canada.

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BOOKS - 2

Speak to the Earth, *by Max Miller, published by Appleton-Century-Crofts, Inc., 35 West Thirty-second Street, New York 1, New York. Pages, 310. Price, $3.75.*

Wide dissemination of this volume, published largely through the efforts of the public relations department of the E. I. du Pont de Nemours & Company, can do much to dispel public misinformation that has plagued the oil industry for many decades. Every device is used to portray oil people as human beings with a de-emphasis on "rich oilman" whitewashing and apple polishing.

A biographical style has been used very effectively by the author to explain in a non-technical manner the various oil industry operations to the general reader. Many interesting sidelights and much of the history of oil in America is woven into the book to attract even the most seasoned petroleum technologist.

The book was written by a leading American fictional writer, the author of **I Cover the Waterfront.**

Design of Piping Systems, *written by members of the engineering departments of the M. W. Kellogg Company, published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, New York. Pages, 365. Price, $15.00.*

This is the second edition of this complete volume on structural design with an emphasis on the flexibility analysis of critical systems.

Engineers of the Kellogg Company, who are noted for many achievements in the mechanical engineering in piping design in high temperature and pressure service, have compiled much information to aid the designer in understanding the significance of stresses on piping performance. The effect of piping reactions on local and terminal components of a piping system has been well treated, as have several newly developed approaches that facilitate the general assessment of average piping.

Offering a complete treatment of the thermal expansion problem, the new addition also gives a method for calculating the effects on uniform loading, such as that due to weight or wind. Space has also been allotted to describe arrangements for expansion joint systems. Problems of supporting, restraining and bracing critical piping systems are discussed. Vibration, flexibility analysis by the general analytical methods and by model test, and approaches for reducing expansion effects are reviewed.

Basic Lubrication Practice, *by Allen F. Brewer, published by Reinhold Publishing Corporation, 430 Park Avenue, New York 22, New York. Pages, 286. Price, $6.75.*

Quick comparison of lubricants for specific machinery under various operating conditions is now made possible in this latest book by a well-known lubrication writer. Complete coverage of lubricants is cataloged for bearings, gears, chain, wire rope, flexible couplings, cams, steam turbines and cylinders, internal combustion engines, power plant auxiliaries, and electric motors. Dual-viscosity figures, centistokes and Saybolt, are used throughout the book in lubrication charts and tables. The book is designed to conform to the individual needs of lubrication and maintenance engineers, executives, purchasing agents, and machine operators.

Boundary Layer Radioactive Tracer Technique, Part 1, Instrumentation, *PB 111677, North Carolina State College for Wright Air Development Center, published by Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. Pages, 107. Price, $2.75.*

Application of a new technique for the measurement of velocity profiles in flowing fluids to the measurement of liquids in laminar flow in round tubes is described in this report of Air Force-sponsored research, released recently to industry. This technique, based upon displacement of a radioactive or dye solution from the tube, has been used successfully for velocity measurements to within 0.002 inch of the wall of a one-half inch diameter tube. Still closer measurements appear possible with minor modifications of procedure.

Application of the tracer-displacement technique with radioisotopes has required development and construction of radiation counting equipment of unusual design. The equipment uses a scintillation detector and can record and operate at counting rates in excess of 500,000 counts per second. Photo-multiplier tubes are used in a dual pulse-counting and current-integrating arrangement so that instantaneous count rates may be obtained under conditions where the counting rate is decreasing 50 per cent a second. Use of dyes as tracers was made possible by adaptation of a spectrophotometer for continuous recording.

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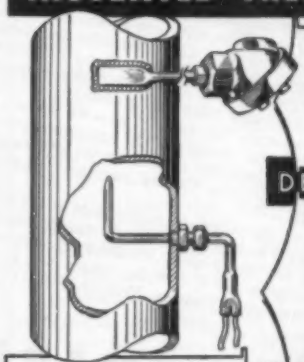

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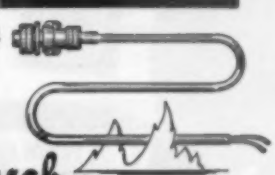

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Small Jerry was very upset because the chain which controlled the wheels of his tricycle was broken. His uncle volunteered to fix it.

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"Oh," he answered, "I've fixed it before. I just didn't want to get my hands dirty this time."

Wife: "'Don't drive so fast, George. The policeman on the motorcycle right behind you wants to get by."

When Tommy asked for a bottle of shampoo at the drugstore, the clerk wanted to know whether it was for oily or dry hair.

"No," Tommy grinned, "it's for wet hair."

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A group of men were in the club before dinner. The talk, for no good reason turned to married life.

"Well," said one fellow, "the real comfort in life comes when you are settled down with one woman you love. You can argue all you want, but it's my opinion that, once they've settled down, most men remain faithful."

Most of the men agreed with him, but an older man in the group shook his head. "I don't agree at all," he asserted. "And if you fellows are honest, you'll know I am right. I'll bet any and all of you men a new hat there isn't one of you who hasn't strayed from the straight and narrow since he's married."

"I'll take that bet," cried one swiftly.

"How long have you been married?" asked the cynic.

"Since last Saturday," was the reply.

The crowd roared, of course—and one of the listeners was so amused that he could hardly wait to get home and tell his wife about it. At the end of the story he laughed and laughed. But his laughter died as he noticed the strange expression on his wife's face. "Don't you think the story very funny?"

"Very funny," she said quietly, "but where's your new hat?"

The little boy was quite sad when he came home from school, and announced to his mother:

"The teacher says I have to write more clearly — and when I do, she'll find out I can't spell."

A fifth grade teacher, recently found this notation at the end of a test paper:

"The views expressed here are not necessarily those of the textbook."

The accountant entered the office of a comparatively new business, and informed the owner that for the first time the firm was out of the red.

"Wonderful!" exclaimed the proud businessman. "Make up seventeen copies of the statement immediately and mail one to my bank and one to each of my creditors."

"Can't do it," replied the accountant. "We have no black ink—we never needed it before."

"Well go out and buy a bottle," ordered the owner.

"Can't do that either," came the answer. "That would put us in the red again."

A book store returned a copy of the Complete Manual of Sex it had ordered from New York with the notation: "Customer couldn't wait."

There is no greater satisfaction in life for some people than parking on what is left of the other fellow's nickel.

You should let your wife know who's boss right from the start. There's no use kidding yourself.

Woman has recently been placed at a disadvantage: Man can now travel faster than sound.

It's hard to appreciate the flower of womanhood if you can't see the stems.

Inflation is when you have a radio that cost $10 before the war and now costs $15 to get it fixed.

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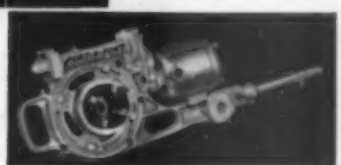

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PERSONALS

H. W. Brown resigned as a director of The Carter Oil Company to become the representative for Europe and Africa on the New York staff of the coordinator of producing activities, Standard Oil Company (New Jersey). **Merrill W. Haas,** exploration manager, was elected a member of the Carter board, continuing in his present position.

M. W. Haas

H. W. Brown

Brown joined Carter in 1935 and has been a director since 1954. Early in 1957 he will return from Europe and Africa to the Jersey producing coordinator's office in New York.

Haas entered the industry in 1933, joined Carter as staff geologist in 1950, became its chief geologist in 1951 and exploration manager three years later.

N. D. Bartlett received an industry tribute at the tenth annual meeting of the Texas Independent Producers and Royalty Owners Association in April in Austin, Texas. Bartlett is the oil editor of the Globe-News of Amarillo, Texas, a position he has held since 1927.

A. E. Herrmann, president of A. E. Herrman Corporation, Amarillo, was elected president of Texas Independent Producers and Royalty Owners. One of the founders of TIPRO and other independent groups, he succeeds **A. P. King, Jr.,** Houston, who is the new vice chairman. The new officers were named at the tenth annual meeting of TIPRO held in Dallas, Texas, April 16-17.

Other officers are: **Vance Foster,** vice president in charge of the oil department for First National Bank of Dallas, treasurer, and **G. Scott Hammonds,** another Dallas independent, secretary.

Those elected vice presidents of the districts are as follows: **J. J. O'Brien,** San Antonio, district 1; **Roger Hamel Jr.,** Victoria, district 2; **M. V. Kelly,** Houston, district 3; **H. L. Miller,** Alice, district 4; **E. C. McCarty,** Dallas, district 5—Dallas; **W. Ridley Wheeler,** Fort Worth, district 5 — Fort Worth; **Harry C. Jones,** Kilgore, district 6; **J. D. Tompkins,** Abilene, district 7-B; **John W. Ellis,** San Angelo, district 7-C; **W. S. Montgomery,** Midland, district 8; **E. M. Burt,** Wichita Falls, district 9; **O. Dale Smith,** Amarillo, district 10.

Steve F. Huston, veteran land man, has been named public relations assistant in the Tulsa, Oklahoma, office of The Carter Oil Company. He has been with Carter's exploration department for 17 years, the past 10 in the division at Mattoon, Illinois.

John R. Suman, retired vice president Standard Oil Company (New Jersey), has been elected chairman of the newly-named advisory board to the department of petroleum engineering of the University of Texas. **John Lynch,** president of La Gloria Corporation heads a committee to study the petroleum engineering department and report on its needs. Others on the committee and advisory board include:

Carl Reistle Jr., vice president, Humble Oil and Refining Company; **A. E. Chester,** vice president, Magnolia Petroleum Company; **J. C. Hunter,** independent operator; **L. F. McCollum,** president, Continental Oil Company; and **William J. Murray, Jr.,** chairman of the Texas Railroad Commission.

Robert B. Rice has been appointed senior research physicist in the physics section of the Ohio Oil Company's Research Center, under construction in Denver, Colorado. He has previously been on the research staff of the Phillips Petroleum Company.

Frederick S. Lott has been named assistant director of the office of oil and gas, Department of the Interior. Lott will direct overall activities in the development and coordination of plans to assure a worldwide supply-demand balance for petroleum and gas and their products. He will also be responsible for the functioning of the foreign petroleum supply committee, and will be a representative of the United States on the petroleum planning committee of the North Atlantic Treaty Organization and head its working group. He began his petroleum career in 1922 with Standard Oil Company, New Jersey, prior to entering federal service in 1934.

Robert J. Rhinehart, division superintendent for the Arkansas Power & Light Company, has been elected president of the National Society of Professional Engineers. He officially takes over his duties as president in July, succeeding **Allison C. Neff,** vice president of Armco Drainage & Metal Products, Inc.

Dr. Alvin L. Benham, the first member of the research department technical staff, has been temporarily assigned to the Los Angeles division of the Ohio Oil Company pending completion of the research center buildings, where he will work under **Walter C. Sheldon.** After the center opens, Denham will report to Denver to help start the research program in engineering.

J. R. Atkinson of Inland Producers, has been elected president of the Indiana Oil and Gas Association. Other officers are: First vice president, **John B. Buchman,** independent producer; second vice president, **Tom Egan,** independent, and secretary-treasurer, **E. J. Reading,** Sun Oil Company.

J. B. Fisher, president of Kendall Refining Company, has been elected a director of Texas Gulf Producing Company. He succeeds **W. H. Hendrickson** who has retired.

Archie D. Gray, general counsel of Gulf Oil Corporation, Pittsburgh, Pennsylvania, has been appointed a member of the American Petroleum Industries Committee of the American Petroleum Institute. He succeeds **David Proctor,** executive vice president and a director of Gulf Oil, who resigned from the committee in February. Gray has been associated with Gulf Oil since 1935 and was named general counsel last February.

Dempsey Montgomery, president of Green Mountain Oil Corporation, San Angelo, Texas, has been named Southwest regional director for Barmello Oil Company, a New York syndicate operating in Oklahoma, Texas, and western Kansas.

Herman H. Kaveler, petroleum engineering and management consultant, was elected president of the Petroleum Club of Tulsa, Oklahoma. Other officers elected are: **R. E. Kirberger,** assistant to management, Service Drilling Company, vice president; **H. M. Cooley,** metallurgist, Bethlehem Steel Company, secretary; and **George A. Clark,** treasurer, Mid-Continent area, Shell Oil Company, treasurer.

Jesse D. Winzenried has been appointed administrative coordinator for Husky Oil Company. Until joining Husky, Winzenried was director of field service research for Tax Foundation, Inc., in New York.

Merle Blakely was named regional public relations advisor for The Carter Oil Company, northern division. He joined Carter as public relations assistant in 1944, becoming assistant manager of the department in 1950.

The First and City National Banks have been consolidated into the First City National Bank of Houston to create one of the Southwest's largest and most experienced staffs for the handling of oil and gas financing. Headed by **George L. Nye,** a professional engineer and geologist, the oil and gas division also includes two vice presidents, **A. G. Gueymard,** and **Ed M. Reed,** and two assistant vice presidents, **W. E. Bridgforth** and **Pete W. Cawthon, Jr.**

Frank M. Brooks, until recently vice president of El Dorado Refining Company, has been made vice president of Sterling Drilling Company.

DEATHS

Jim Flowers, 75, an independent oil operator and rancher, died in a Dallas hospital March 26, after a three-month illness. Born in Gradyville, Kentucky, he had lived for the past 30 years in Dallas, Wichita Falls and Midland, Texas.

Gilbert Black Myers, 49, comptroller of Plymouth Oil Company, and a member of the firm since 1925, died March 29 in Pittsburgh, Pennsylvania.

John E. Morrow, independent operator of Pittsburgh, Pennsylvania, died at his home in March. As an associate of Mickael L. Benedum, he had drilled from the East Coast to the Rockies and the Gulf.

D. B. Lesh Jr., part owner of D. B. Lesh Drilling, died March 16 as a result of an automobile accident near Casey, Illinois.

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The U. S. Department of Commerce has just issued its second edition of *Developing and Selling New Products,* of interest to manufacturers, both large and small . . . or to anyone with an idea for a new product.

You may obtain a copy of Developing and Selling New Products for 40 cents from the Dallas Field Office of the Commerce Department, 1114 Commerce Street, Dallas, Texas.

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Here is a rugged hand-tool that "works around corners" for removing old packing from stuffing boxes. The picture shows how a pair of these flexible handled tools operate around obstructions for snagging out those old packing rings. All steel — tempered tool steel cork-screw bit.

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OIL and GAS TRADE NEWS

GM Plant Space To Be Increased

Manufacturing space of Electro-Motive Division of General Motors at its No. 1 plant in McCook, Illinois, will be increased 42 per cent, to be in operation early in 1957.

Two thousand new jobs for workmen in many skilled classifications will be created by the expansion with hiring to start as rapidly as any part of the new facilities is ready for operation. Some operations will be ready late this fall.

The various additions to the manufacturing facilities will provide over 805,000 sq ft of new floor space.

Larger Plate Bender Installed

A new twin press for bending large boiler drum half shells has been installed at the Barberton, Ohio, works of The Babcock & Wilcox Company.

The press, designed and built by B&W employees, will double the plant's plate-bending capacity. This new press has a capacity of 5000 tons and stands over 25 ft high. It is capable of bending a steel plate up to 7½ in. thick and 36 ft long. A plate this size would weigh about 50 tons.

Take Part in General Sales Meet

Attending the sixteenth annual general sales meeting of Stewart & Stevenson Services held recently in Houston, Texas, were representatives of General Motors, Chrysler, Climax and Wade'Rain along with Stewart & Stevenson dealers and representatives throughout Texas.

Ross Stewart, president of Stewart & Stevenson, and Joe Manning, vice president and general manager, presided.

Speakers included these representatives from the Detroit Diesel Engine Division of General Motors: R. E. Hunter, general sales manager; R. V. Baxley, operations manager, and A. F. Campbell, manager petroleum industrial sales. Among the other speakers were Robert M. Morgan, national sales manager, R. M. Wade Co.; Lowell Firstenberger, president, and E. A. Everett, national sales manager of Feese and Firstenberger.

John M. Carsey, age 89, attended the meeting and was introduced by Stewart as the "dean" of the Stewart & Stevenson Diesel Engine organization.

Engineers Conduct Classes

Engineers of the Engine Life Products Corporation of El Monte, California, recently figuratively donned cap and gown and became professors for a day.

The "campus" was the Morrison-Knudsen Company of Boise, Idaho, operators in earth-moving and dam building construction. Morrison-Knudsen inaugurated a program of conducting a series of classes for a chosen group of employees on the various aspects of maintenance that affected their work.

Classes in filtration and standardization were by arrangement made the responsibility of Engine Life Products, which furnished a display unit that simulated the hydraulic system of engines commonly used in the industry. Along with this display unit actual full-flow filters and shunt-type filters were put into operation, which demonstrated and schooled the men in how each unit worked.

Northern Built Drilling Barge

The first mobile oil drilling barge ever built north of the Gulf Coast has been floated down the Monongahela River from Brownsville, Pennsylvania, for service in the Louisiana and Texas swampland.

The barge was designed and built by Hillman Barge and Construction Company and United States Steel supplied equipment.

Hillman built the water-borne drilling rig at its Brownsville shipyard. It is equipped to recover oil from deep wells located in swamplands and inland waterways. Two stiff-leg derricks with 40-ft booms for handling steel drill pipes and casing have been installed at Brownsville. A 142-ft derrick will be installed at New Orleans, Louisiana, to complete the drilling unit. The huge floating "swamp rig" provides luxury liner quarters including air conditioning for operating personnel.

This equipment will be operated by Carnes Weaver Barge Drilling Company, Inc., Houston, Texas, on the Gulf Coast shoreline of Louisiana and Texas.

Lightweight Steel Pipe Announced

Valley Manufacturing Company has announced that it is now producing lightweight steel pipe in 6 and 8-in.diameters. The new product is butt welded and is manufactured in 20, 30 and 40-ft lengths.

Production facilities to produce 10-in. diameter will be installed later this year. Ten, 12, and 14-gage steel is used.

Continuous pipe production from the mill allows manufacture of four miles of pipe per day.

Koppers Begins Own Overseas Firm

Koppers Company, Inc., has announced the formation of a new international company to handle all its foreign activities including product sales, and overseas plant operations.

Fred C. Foy, president and chief executive officer of Koppers, will also serve as president of the newly created company to be known as Koppers International. C. A. George W. Naylor has been elected vice president and general manager of the new international company. In addition, Naylor was elected a vice president of the parent concern.

Also elected as vice presidents of Koppers International, C.A. are Fred W. Rys, who will be manager of construction projects, and Frank B. Varga, who will be manager of process and royalty operations.

Celanese Planning New Lab

Celanese Corporation of America has awarded the general contract for construction of the first unit of its new Charlotte Development Laboratories to Boyd & Goforth Construction Company, Inc., Charlotte, North Carolina. Construction will start immediately.

Located on a 114-acre tract. the new unit will be known as the process development laboratory and is to be finished later this year. It will have 30,000 sq ft of floor space. The two-story main section of the L-shaped building will house offices, laboratories, and pilot plants, while the one-story wing section will provide space for shops, storage, and utilities.

Representatives of General Motors, Chrysler, Climax and Wade'Rain were among those who participated in recent general sales meeting, pictured, Stewart & Stevenson Services at Houston, Texas.

O-C-T Purchases Interest in Firm

Purchase by Oil Center Tool Company of 50,000 shares of common stock of Thermal Research & Engineering Corporation of Conshohocken, Pennsylvania, has been announced jointly.

Oil Center Tool has also purchased options for 100,000 shares exercisable over a period of years.

Thermal Research & Engineering is engaged in the design and manufacture of high-velocity, high-heat release, gas, oil, and combination gas and oil burners, together with a line of heat equipment utilizing the unique properties of its burners.

John F. Maher, O-C-T president, is a director and substantial stockholder of Thermal Research & Engineering.

Being in the position of receiving instead of delivering the build-up was a switch for Don L. Baxter, right, president of Don L. Baxter, Inc., oil and gas industry advertising agency. L. D. (Red) Webster (left), vice president of Lone Star Steel Company, was co-master of ceremonies at a testimonial luncheon given Baxter by his clients recently at the City Club in Dallas, Texas. Occasion was Baxter's twenty-fifth anniversary as an advertising executive and the tenth anniversary of the founding of his firm, which regularly advertises over 100 items of oil field equipment for clients.

Worthington Acquires Division

Worthington Corporation and the Mason-Neilan Regulator Company, Boston, Massachusetts, have announced an agreement for the transfer of the net assets and name of Mason-Neilan to Worthington in exchange for Worthington common stock.

The Mason-Neilan plant and facilities will be operated as the Mason-Neilan Division of Worthington, and the entire working force and management staff will be continued in their present positions.

The full line of Mason-Neilan products will continue to be manufactured, including instruments and valves designed to control the pressure, temperature and flow of the liquids, and gases and components incident to industrial processes.

Other news from Worthington is that the company has unveiled a new, fully equipped welding research laboratory recently at its Harrison, New Jersey, division. The new facility will be used for welding application research, designing for welded construction, and building of prototype models.

Motorola Expands Sales Set-Up

A major expansion of the national sales structure of Motorola Communications and Electronics, Inc. — the establishment of four geographical sales divisions and the appointment of six vice presidents — has been announced.

In the new alignment, Arthur L. Reese, formerly assistant secretary, was appointed vice president and operations manager. Eugene S. Goebel, formerly national sales manager, was named vice president for market relations.

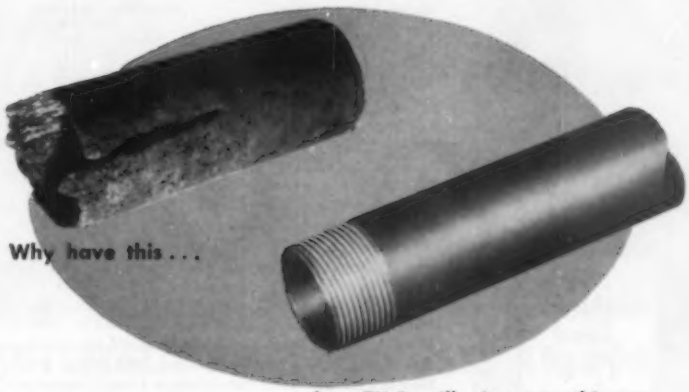
Four former regional managers in the field were elevated to vice presidents and placed in charge of the new sales divisions. They are: Lowell E. White, eastern sales division manager; Homer L. Marrs, central sales division manager; Edward L. Falls Jr., southern sales division manager, and Donald F. Brickley, western sales division manager.

The eastern sales division covers a 15-state coastal area, including the Carolinas, the Virginias, Pennsylvania, New York, and all of New England. Headquarters will be at Fort Lee, New Jersey. Central sales division includes a 13-state area, including the Dakotas through Ohio, and everything north of the Oklahoma-Arkansas-Tennessee borders. Headquarters will be in Chicago, Illinois.

Southern sales division is made up of the 10-state area of New Mexico, Texas, Oklahoma, Arkansas, Louisiana, Tennessee, Mississippi, Alabama, Georgia, and Florida, with headquarters in Dallas, Texas. In the 10-state western sales division area are Arizona, Colorado, Wyoming, and Montana through to the coastal states. San Mateo, California, is division headquarters.

TK-2 PLASTIC LININGS

Dependable protection against corrosion and paraffin deposits...



when TK-2 will give you this.

TK-2 dependability as protection against corrosion and paraffin deposition is being proved every day in major oil fields throughout the world.

The reason for this dependability is Tube-Kote workmanship: Careful inspection of every process — cleaning, sandblasting and multiple applications — and with every phase carefully controlled by exacting Tube-Kote engineers.

Learn why TK-2, the thermo-bonded plastic lining for pipe and tubing, is the specified choice of so many major companies. Write for free 1956 TK-2 brochure.

TUBE-KOTE T.M. REG.

TUBE-KOTE, INC.

P. O. Box 20037

Houston 25, Texas

PIONEERS IN PLASTICS SINCE 1939

MANUFACTURERS-EXTRUDERS OF PLASTIC PIPE FOR THE OIL INDUSTRY

New Subsidiary Formed

Commercial Filters Corporation of Melrose, Massachusetts, has announced the merger of two filter lines — Honan-Crane and Michiana — to form a new subsidiary, Indiana Commercial Filters Corporation.

This action follows the Massachusetts firm's recent purchase of Houdaille-Hershey of Indiana, Inc. (makers of Honan-Crane filters), and the filter-division of Michiana Products Corporation.

Honan-Crane and Michiana manufacturing, research and engineering facilities will be consolidated at Lebanon, Indiana. The Honan-Crane and Michiana filter lines will be retained under their present names, while a new brand name, "CFC," will identify filtering and conveying equipment formerly known as "Houdaille."

An integrated sales organization has been established to market the products of both companies. To head the sales organization, Charles I. Wallace has been elected vice president in charge of sales. Wallace is also vice president and general manager of Indiana Commercial Filters, with headquarters at the Lebanon plant.

Cummins 'Mobile Diesel Center'

The service division of Cummins Engine Company, Inc., is now sending a "mobile diesel center" to the field.

Purpose of the mobile demonstration unit is to bring the latest service information on Cummins diesels directly to service men throughout the country.

The Cummins Mobile Diesel Center is unique in that it is a self-contained unit having its own stage, lights, chairs, public address system, props, etc., all built into a single package. The body is transported on an International Harvester Model CO 205 tractor powered with a 175 hp Cummins JT-6-B Turbodiesel. Lowering and raising of the body is accomplished by three built-in hydraulic jacks operated from a 110-v electrical system. Set-up time for the complete show is only 50 min.

Materials carried in the mobile diesel center will permit tailored programs that will be directed to owners, maintenance superintendents, shop foremen, driver and safety supervisors, and drivers, as well as Cummins distributor personnel.

Two Companies Plan to Merge

Boards of directors of Hooker Electrochemical Company and Niagara Alkali Company, both of Niagara Falls, New York, have approved a formal agreement for the consolidation of the two companies, subject to the approval by the stockholders of each company.

Under the terms of the proposed consolidation, Hooker will be the continuing company. The consolidation will be effected by the issuance of 1.6 shares of common stock of Hooker for each of the presently outstanding 600,000 shares of common stock of Niagara.

Alco Announces Expansion

Alco Products, Inc., has announced an expansion plan for its Beaumont, Texas, plant, former Beaumont Iron Works Company, amounting to over $1,500,000. With the aid of the Beaumont Chamber of Commerce, the company is completing transactions to purchase more than two acres of land adjacent to its present property.

Plans call for construction of a combination warehouse-office building on the newly acquired land, plus expansion of Alco's present manufacturing facilities, with completion scheduled in June.

The building will include 14,000 sq ft of storage space plus 6000 sq ft of office space.

Weco Holds Ground Breaking

Ground breaking for Well Equipment Manufacturing Corporation's new 76,000 sq ft air conditioned office and plant in Houston, Texas, has been held.

After occupying its new plant in September, Weco will manufacture Chicksan swivel joints, mud guns and steel rotary hoses in addition to its own complete line of wing unions, snatch blocks, and compounds. Well Equipment Manufacturing Corporation is an operating division of Chiksan Company, a subsidiary of Food Machinery and Chemical Corporation.

Fuller Builds Large Cooler

The Fuller Company, a subsidiary of General American Transportation Corporation, has completed assembly of the largest inclined-grate material cooler it has ever built.

Designed to cool phosphate nodules issuing from the rotary kiln of a large chemical plant, the unit has a grate 10 ft wide and 60 ft long. The unit will receive the phosphate nodules from the kiln at a rate of 1500 tons per day. Its principal function will be to cool the phosphate from 2400 F to 250 F.

The cooler alone weighs approximately 182,000 lb without the refractory brick, which is to be installed in the field, making the total weight of the installed unit almost 250 tons.

WHEELING
COUPLINGS
FOR OIL COUNTRY USE
LINE PIPE COUPLINGS A.P.I.
1/8" to 12" — Seamless and Special Processed — Black or Galvanized
PLAIN TUBING COUPLINGS A.P.I.
1" to 4" — Seamless
EXTERNAL UPSET TUBING COUPLINGS A.P.I.
3/4" to 3 1/2" — Seamless
CASING COUPLINGS A.P.I.
4 1/4" to 13 3/8" — Long or Short
HYDRAULIC COUPLINGS
1/8" to 4" — Seamless
REAMED AND DRIFTED A.I.S.I.
3/4" to 12" — Seamless or Special Processed
DRIVE PIPE COUPLINGS
3/8" to 12" — Seamless or Special Processed
Sales Offices in Leading Cities:
Albany, N. Y.—Albert L. Becker, 434 Clinton Ave.
Baltimore, Md.—Ted Barto, 2301 No. Charles St.
Chicago, Ill.—Harry A. Jay, Suite 1090, Old Colony Bldg.
Denver, Colo.—Earl H. Jones & Co., 1863 Wazee St.
Detroit, Mich.—R. W. Lang, Jr., 505 Park Avenue
Erie, Pa.—R. J. Maggi, Box 711
Falmouth, Mass.—Walter S. Bennett, 53 Minot St.
Houston, Texas—Henry H. Paris Distributor, Inc., Box 932
Los Angeles, Cal.—James A. Riordan Co., 1400 Santa Fe Avenue
Louisville, Ky.—Sid. Schultze Co., 514 W. Main St.
Milwaukee, Wis.—M. A. Nelson Co., 3347 N. 97th St.
Minneapolis, Minn.—Lin J. Krause, 5605 Lyndale Ave. S.
Narberth, Pa.—J. W. Worthington, 105 Forrest Ave.
Newark, N. J.—Ira L. Rothenberg & Assocs., Industrial Office Bldg., 1060 Broad St.
New York, N. Y.—Max Rothenberg, 11-05 38th Ave., Long Island City
Omaha, Neb.—Wm. Freiden, Central States Engineering & Sales Co., 5101 Blondo St.
Oswego, N. Y.—Northeastern Associates, Inc., Neil Chatterton, Secretary, P. O. Box 284
Portland, Ore.—Earl H. Jones & Co., 1233 NW 12th Ave.
Richmond, Va.—P. C. Abbott & Co., 15 E. Franklin St.
San Francisco, Cal.—Earl H. Jones & Co., 1150 Folsom St.
Seattle, Wash.—Earl H. Jones & Co., 819 Thomas St.
TOP QUALITY Since 1918
WHEELING MACHINE PRODUCTS COMPANY
WHEELING, WEST VIRGINIA
Factories at WHEELING, W. VA. and WOODLAKE, CALIFORNIA

TRADE PERSONALS

Carl H. Simon has been elevated to the position of vice president and general manager of Darling Valve & Manufacturing Company. In this position, Simon assumes full responsibility for all Darling Valve operations. **Dick F. Sable** assumes the position of general sales manager. Sable was formerly Southwest regional manager and will retain his offices in Dallas, Texas, Southwest regional headquarters.

C. H. Simon

D. F. Sable

Thomas C. Jester has been promoted to chief engineer. Jester was formerly assistant chief engineer. **James N. Elwood,** former plant manager and general superintendent, is now manager in charge of manufacturing. **Packer B. Young,** former assistant sales administrator, has been made assistant sales manager.

D. W. Oram

Max Bowerman

Dan W. Oram has been named executive director of sales by the Klemp Metal Grating Corporation, having recently been associated with Kerrigan Iron Works, Inc. as head of the market development division. Oram will serve as international executive director of sales for Klemp.

Max Bowerman has been promoted to the position of general manager of Hycalog, Inc., from his former one of manager of operations. He recently completed his tenth year with Hycalog.

James P. Wiseman, president of Fluor Products Company, Whittier, California, has been elected president of the Cooling Tower Institute for 1956. Outgoing president is **Neal B. LauBach** of Hudson Engineering Corporation, Houston, Texas.

Other new officers are **Forrest B. Reed,** The Marley Company (Kansas City, Missouri), vice president; **Karl E. Johnson,** J. F. Pritchard & Co. of California (Kansas City), secretary, and **Denis E. O'Neil,** Foster Wheeler Corporation's cooling tower department (San Mateo, California), treasurer.

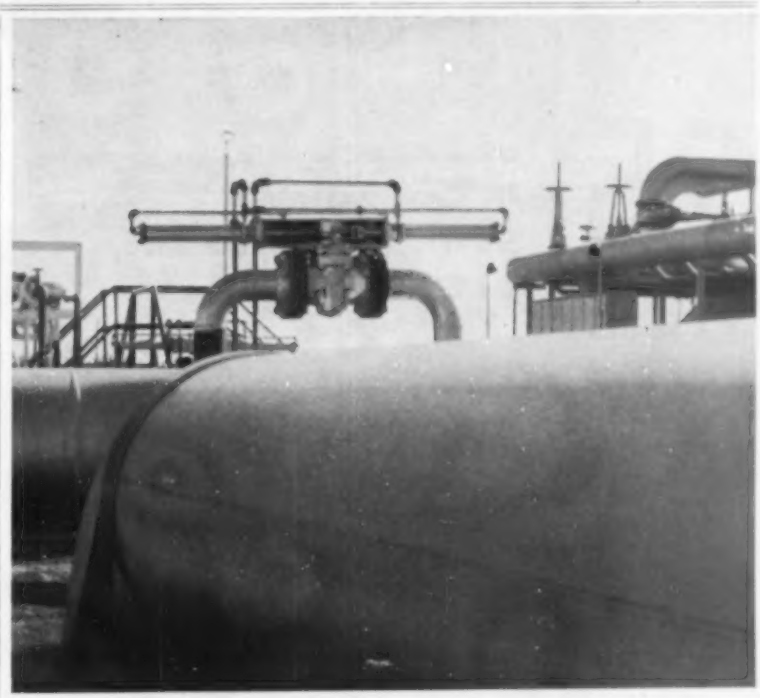
Stephen L. Ingersoll has been elected president and general manager of the Ingersoll Steel Division of Borg-Warner Corporation. He succeeds **H. G. Ingersoll,** who has retired from that position. Stephen L. Ingersoll was elected executive vice president in 1954, having first joined the division in 1920.

H. G. Ingersoll, who is leaving the presidency of the division after five years in that post, is a vice president and director of the parent Borg-Warner Corporation.

Richard M. Firth has been promoted to vice president of production and engineering and **Charles G. Tullis** to chief engineer for Southwest Industries, Inc. Firth has many years experience in the packaged gas compressor field. Tullis' engineering and professional experience has been in the field of packaged compressors.

Leonard J. Cogan has been promoted to sales manager for Graver Tank & Manufacturing Company, Inc. Cogan will be responsible for all sales of Graver Tank, with the exception of the Mid-Continent division, the Graver Construction Company, Inc., and the Graver Water Conditioning Company.

His previous duties were that of assistant manager of eastern sales with headquarters in Philadelphia, Pennsylvania.



AUTOMATIC BLOWDOWN SYSTEM FOR COMPRESSOR STATION OPERATED BY LEDEEN VALVE ACTUATORS

New AGA Code Revision Specifies Emergency Shutdown Facilities...

"Each transmission compressor station shall be provided with an emergency shutdown system by means of which all gas compressing equipment, all gas fires, and all electrical facilities in the vicinity of gas headers and in the compressor building can be shut down and the gas can be blocked out of the station and the station gas piping blown down." (per Paragraph 843.431, Emergency Shutdown Facilities, Revision of Section 8 of ASA B31.1).

WRITE FOR BULLETIN 3020.

VALVES • CYLINDERS
VALVE ACTUATORS
AIR HYDRAULIC
PUMPS & BOOSTERS

Ledeen Mfg. Co.
1608 San Pedro St.
Los Angeles 15, Cal.

Trade Personals

▸ **Ira L. Kasindorf** has been named to the position of chief development engineer of the eastern components division of Servomechanisms, Inc.

▸ **E. D. Tull,** executive vice president of the Cummins Engine Company, Inc., has been elected president of the Internal Combustion Engine Institute. He succeeds **B. G. Van Zee,** chief engineer of the Minneapolis Moline Company, who continues as a member of the board of directors.

Other newly elected officers are: Vice president, **F. C. Langston,** special representative general management of the Harnischfeger Corporation; treasurer, **C. E. Nelson Jr.,** secretary and treasurer of Waukesha Motor Company, and secretary, **Phil Norton,** executive vice president of the Wisconsin Motor Corporation.

▸ **W. B. Sharp** has been elected chairman of the board and president of Mission Manufacturing Company. **Richard E. White** was named executive vice president, and **Anan Golub** vice president, secretary and treasurer. Other directors chosen were **W. T. Campbell, D. C. Sharp Jr.,** and **Ross Bennett.**

▸ **A. G. Chandler** has been named manager of special sales for Security Engineering Division, one of the Dresser Industries.

▸ **Daniel E. Lehane** has been named manager of sales engineering for Chromalloy Corporation. His most recent position was that of sales engineer in the New York City office of the Standard Steel Works division of Baldwin-Lima Hamilton Corporation.

▸ **F. L. Tyler** has been appointed manager of Reed Roller Bit Company's European subsidiary, Reed Roller Bit Company (Nederland) N. V., the Hague, Netherlands. Tyler was formerly Reed's Pacific Coast sales division manager in Los Angeles, California, and has been associated with Reed since 1940.

F. T. Tyler

W. A. Oberholtzer

▸ **William A. Oberholtzer** has been appointed as vice president-finance of Delta Tank Manufacturing Company, Inc. He joined Delta after several years service as controller and secretary-treasurer of Black, Sivalls & Bryson, Inc.

▸ Grant Oil Tool Company has opened new service facilities and warehouse at Harvey, Louisiana. **John Kinkaid** has been transferred from Lafayette, Louisiana, to Harvey, where he will manage the company's new facilities. He had served as office manager of the Lafayette branch since 1955 until his present promotion to assistant district manager of the Louisiana branch, working out of Harvey.

New field representative at Lafayette is **Joe Jennings,** transferred to his present post from the Los Angeles Basin branch in California.

Titus "Nick" Carter has joined Grant as a field salesman in the Los Angeles Basin area. He will work out of Grant's Compton, California, branch.

▸ **C. H. Slayton Jr.** has been named director of engineering of the Parkersburg-Aetna Corporation. Slayton will make his headquarters in Parkersburg, West Virginia.

Previous to taking his new position, he was employed by the General Electric Corporation. He served seven years at GE's chemical and metallurgical division at Pittsfield, Massachusetts, and five years with the company's aircraft gas turbine division at Cincinnati, Ohio.

C. H. Slayton Jr.

J. H. Judge

▸ **James H. Judge** has been named assistant to the president, a newly created position, for American Meter Company, Inc. Judge will be primarily engaged on special projects concerning positive displacement liquid metering, a field in which he has had more than 32 years' experience.

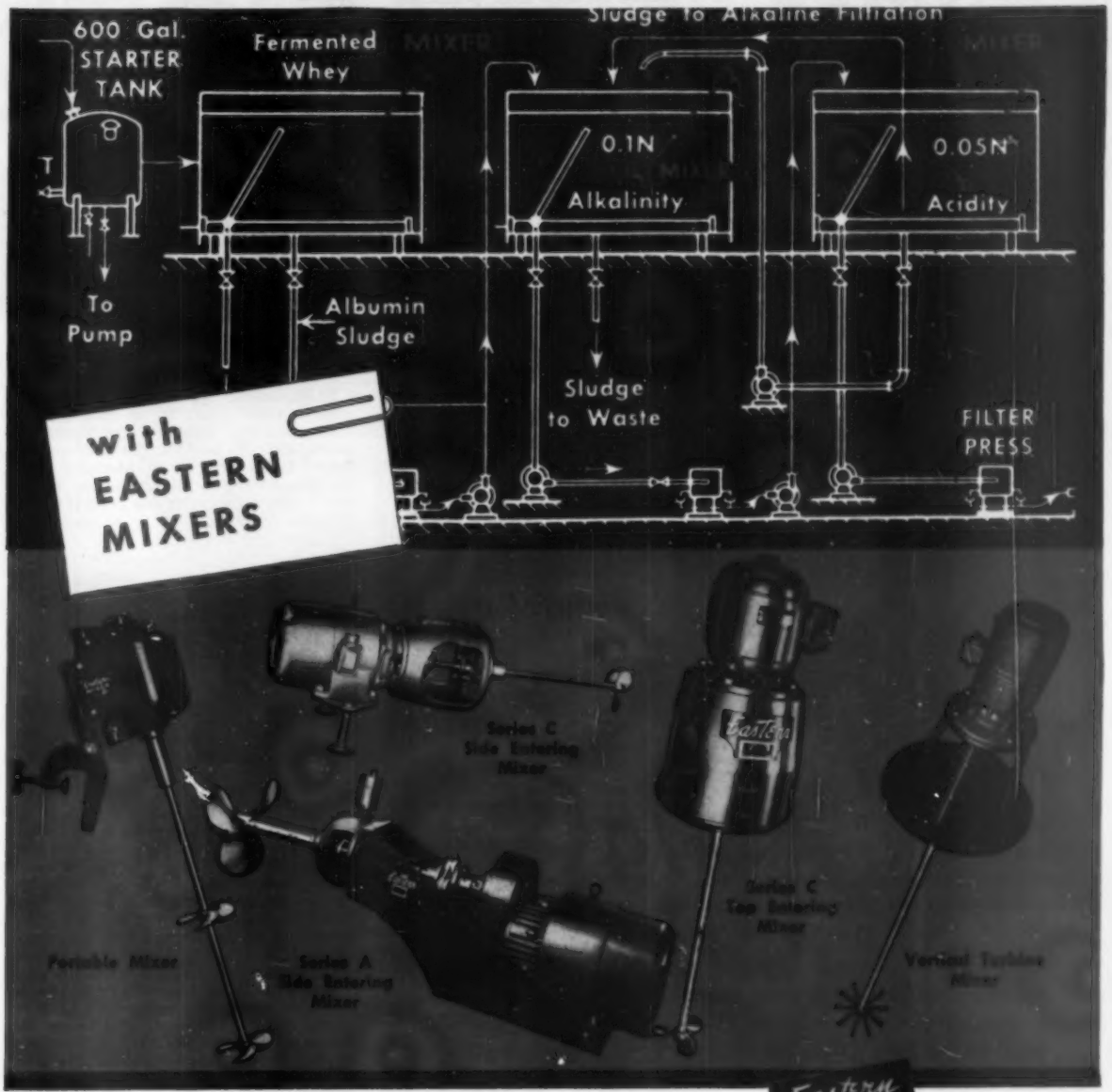
25 YEARS of Experience in Correcting SCALE, CORROSION, ALGAE Problems

D. W. HAERING & CO., INC.

ANALYSTS • CONSULTANTS • MANUFACTURERS

SAN ANTONIO, TEXAS

RELIABLE FLUID MIXING in PROCESSING



Eastern's Mixers are designed to meet the needs of today's chemical and industrial processes. Many types are available to satisfy all conditions of fluid consistencies and tank sizes. Selection may be made from a wide range of horsepower, speed, and construction materials. Motors with various voltage ratings and enclosures are also furnished.

PORTABLE MIXERS

Series H at 1725 R.P.M., Series S at 1125 R.P.M., and Series G at 420 R.P.M. are available in motor ratings from 1/20 to 5 H.P. Also available are special speeds, variable speeds, as well as air driven models.

TOP AND SIDE ENTERING

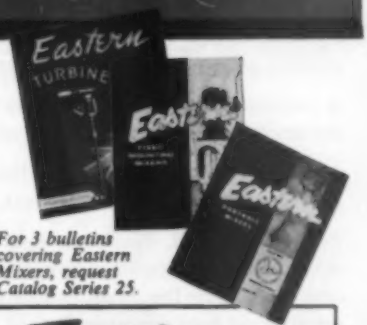
Series A, extra heavy duty for large tanks, are available in side entering units only within a range of 5-30 H.P. with standard speeds of 280, 420, and 1150 R.P.M.

Series C, for average tank capacities, are available in sizes of ¼ to 10 H.P. at these standard speeds: 1725 R.P.M. (up to 5 H.P.); 1140 R.P.M. (up to 10 H.P.); 420 R.P.M. (up to 7½ H.P.); 280 R.P.M. (up to 5 H.P.). Available in both horizontal and vertical models.

TURBINE MIXERS

Eastern's Top and Bottom Entering Turbine Mixers find particular application where liquid blending requires gentle, yet thorough agitation.

Models are available in sizes from ¼ to 40 H.P. Standard speeds are 56, 68, 84, 100, 125, 155 R.P.M.



For 3 bulletins covering Eastern Mixers, request Catalog Series 25.

Eastern
INDUSTRIES, INC.
Mixer Division
Regent St., Norwalk, Conn.

Trade Personals

▸ **Pete W. Cawthon Jr.** has been promoted from assistant cashier and petroleum engineer to assistant vice president in the oil and gas division of the City National Bank of Houston, Texas. He joined the bank as a petroleum engineer in 1950.

▸ **Joe M. Winter** has been appointed manager of sales and service of the California district for Franks Division, Cabot Shops, Inc. He is replacing **R. M. White,** who has resigned.

▸ **Alton L. Gray** has been promoted to assistant general sales manager of the Pfaudler Company. **Edgar N. Fox Jr.** has been named Rochester, New York, district sales manager, replacing Gray. **Robert C. Silver** has been advanced to field sales engineer replacing Fox in the Rochester-Niagara Frontier district.

▸ **Jack Grundy** has been named factory manager for Reed Roller Bit Company. **C. L. McKee** has been made production manager.

▸ **George W. Russell** has been named general manager and **Alden R. Loosli** assistant general manager of American Cyanamid Company's industrial chemicals division. Russell, formerly assistant general manager of the company's pigments division, has been with Cyanamid since 1946. Loosli, formerly assistant general manager of the fine chemicals division, has been with Cyanamid since 1937.

▸ **C. A. Sanders** has been promoted to director of credits for Mid-Continent Supply Company. Sanders, formerly assistant to the treasurer, has been with Mid-Continent since 1938.

▸ **Herbert Kay** has been named manager of catalyst development for Climax Molybdenum Company, previously having been in charge of new chemical development. Kay joined Climax Molybdenum about a year ago when the company established its chemical development division.

Herbert Kay

E. M. Gearke

▸ **E. M. Gearke** has been named assistant general sales manager for Baash-Ross Tool Company, division of Joy Manufacturing, with his headquarters in Houston, Texas. Gearke has been associated with the Baash-Ross organization for many years, most recently serving as Gulf Coast area sales manager.

J. S. Blair Jr.

G. R. Bond

▸ **James S. Blair Jr.** has been appointed sales manager, drilling equipment, for The National Supply Company. He succeeds **W. T. Cushing,** who was appointed to the newly created position of manager of industrial sales. Blair joined National Supply at its Jennings, Louisiana, store in 1941. In 1955, he was made manager of the company's Venezuelan subsidiary.

Gerald R. Bond has been named sales manager, production equipment, for National Supply, succeeding **Thomas B. Herndon,** recently promoted to manager of oil field sales. Bond joined the company in 1950 as a warehouseman at the Casper, Wyoming, store and since 1954 has been a sales representative for the Northwest division, with headquarters in Denver, Colorado.

▸ Six Lane-Wells Company district executives have moved to new posts. **E. A. Radack,** formerly district superintendent, Southern Louisiana district, in New Iberia, has moved to New Orleans on temporary assignment as assistant to the division manager. **C. E. Shilcutt** has come from West Texas to Houston, where he will be district manager. **J. W. Kiser** has become district manager of the West Texas district, operating from Odessa. **R. G. Grant** has moved from his New Orleans post as district sales engineer to Shreveport, Louisiana, where he will be district manager of the Arklatex district. **W. D. Long Jr.,** formerly in the West Texas district, has taken over Grant's post as district sales engineer for the Southern Louisiana district.

Oil Pumping "Automation" an Actuality with this WISCONSIN-POWERED Installation

Natural gas provides a continuous fuel supply for this Model TFD 2-cylinder Wisconsin Air-Cooled Power Unit, equipped with clutch reduction, direct-connected to a medium pressure rotary pump, delivering 35 bbls. per hour at 300 lbs., operating in an oil field in Stephens County, Okla.

A Time Clock automatically shuts down the unit at a predetermined time, doing away with the necessity of having the operator come back to the pump and engine after once started.

Automatic High Temperature Safety Switch and Low Oil Cut-out Switch provide positive safeguards against preventive maintenance negligence.

A vacuum-operated Gas Regulator automatically shuts off the gas when the engine stops as another self-controlled operating and safety feature.

Automatic, continuous AIR-COOLING at temperatures up to 140°F provides the final step in efficient, safe oil-well-pumping *Automation!*

And to top it off, Wisconsin heavy-duty engineering design and construction are assurance of low-cost maintenance, dependable operation and long engine life. Reasons why it pays to specify "Wisconsin Power" for *your* oil field equipment.

WISCONSIN MOTOR Corporation
MILWAUKEE 46, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

WRITE TO HARLEY SALES CO.
619 SOUTH MAIN STREET • TULSA, OKLAHOMA
5420 McKINNEY AVENUE • HOUSTON, TEXAS
809 SOUTH MAIN STREET • WICHITA, KANSAS
OIL FIELD DISTRIBUTORS FOR WISCONSIN ENGINES AND ALL TYPES OF UTILITY UNITS

A 8806-1½T

When Line Pipe Wears A STRAIT-JACKET

Open section of Hydropress is shown only to illustrate operation. Length of pipe is completely encased during expansion.

THE "Strait Jacket" is an important step in the Youngstown process of producing high strength line pipe to API-5LX specifications. This "Strait Jacket" is actually a hydraulic expansion unit in which the pipe is expanded within a set of enclosed dies. In this operation the ends are sealed, water is forced into the pipe and pressure is increased to expand it evenly against the smooth steel walls of the expander.

This process proof tests and cold works the pipe simultaneously. As a result Youngstown Electric Weld Line Pipe with uniformly high strength, with uniform weld quality, with uniform straightness, with uniform wall thickness and with uniform diameter is ready for you.

* * * * * *

Five reasons why Youngstown Electric Weld Line Pipe is your best buy: (1) It bends readily; (2) Wall thickness is uniform; (3) Line up characteristics are excellent; (4) Weldability is outstanding; (5) Long lengths save you time and trouble. The Youngstown Sheet and Tube Company, Youngstown 1, Ohio. Sales and service offices throughout the oil and gas producing areas.

Youngstown

ELECTRIC WELD LINE PIPE

QUALITY YOUNGSTOWN SERVICE

THE YOUNGSTOWN SHEET AND TUBE COMPANY *Manufacturers of Carbon, Alloy and Yoloy Steel*

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SHEETS - STRIP - PLATES - STANDARD PIPE - LINE PIPE - OIL COUNTRY TUBULAR GOODS - CONDUIT AND EMT - MECHANICAL TUBING - COLD FINISHED BARS - HOT ROLLED BARS - WIRE - HOT ROLLED RODS - COKE TIN PLATE - ELECTROLYTIC TIN PLATE - BLACK PLATE - RAILROAD TRACK SPIKES - MINE ROOF BOLTS

ONE OF THE DRESSER INDUSTRIES

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CLARK BROS. CO., Olean, New York—Gas turbines, engines, and reciprocating, centrifugal and axial flow compressors — gas, steam, electric and diesel driven.

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DRESSER-IDECO DIVISION, Columbus, Ohio — Radio and television broadcasting towers, steel buildings, aircraft hangars, mechanical parking garages, electric power substations.

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DRESSER MANUFACTURING DIVISION, Bradford, Pa. — Pipe line couplings, pipe repair sleeves and clamps, weldments, forgings, welding fittings, flanges, rings.

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Magcobar.

MAGNET COVE BARIUM CORP., Houston, Tex.—Magcobar and Magcogel drilling muds and other specialized oil well drilling fluids and chemicals.

PACIFIC

PACIFIC PUMPS, INC., Huntington Park, Calif — Centrifugal pumps for refineries, power stations, pipelines, and chemical plants; plunger pumps for oilwells.

ROOTS RC SINCE 1854 CONNERSVILLE

ROOTS-CONNERSVILLE BLOWER DIVISION, Connersville, Ind.— Rotary positive blowers, gas pumps, centrifugal blowers, exhausters, and positive displacement meters.

Security

SECURITY ENGINEERING DIVISION, Dallas, Tex., Whittier, Calif. — Rock bits, reamer rock bits and hole openers; reamers, casing scrapers and Neo-Red rubber stabilizers.

Tomorrow's progress planned today

Look for this symbol

...it identifies all Dresser Companies and their products... it is your guarantee of the DRESSER *plus*+

You gain an important extra plus value every time you are served by any of the Dresser companies. This is the unique way Dresser operates to serve you better. Each Dresser company works independently to assure maximum individual attention to your specific needs . . . yet all are teamed together in a single organization to provide a group of research, engineering, and manufacturing services. From Dresser you obtain equipment based on the over-all experience of many companies in many industries.

As performance demands on equipment become increasingly greater, Dresser will continue to pace the technological changes in your field. You can count on the Dresser companies as major suppliers of equipment researched and developed to serve you better and meet your future needs.

Wherever you are, whatever your needs, specify equipment from Dresser companies. No other single organization offers you the same broad range of "know-how" coupled with individual company attention to these specific needs. Be sure to look for this symbol – it's your guarantee of the Dresser *Plus*+ . . . the mark of superior equipment and services which have become the standard of comparison the world over.

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LANE-WELLS CO., Los Angeles, Calif., Houston, Tex., Oklahoma City, Okla.—Electric and Radioactivity Well Logging, Koneshot perforating and bullet perforating, packers and bridging plugs.

SIE

SOUTHWESTERN INDUSTRIAL ELECTRONICS, Houston, Tex.—Seismograph systems and instruments—electronic, electro-mechanical. Computers—analog and digital; recording systems. Special transformers, reactors.

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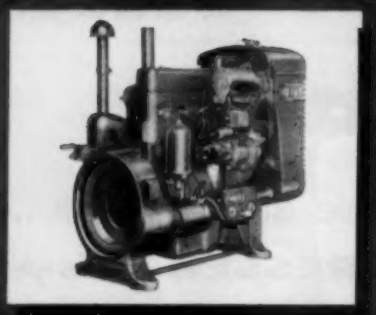
REPUBLIC NATIONAL BANK BUILDING • POST OFFICE BOX 718 • DALLAS 21, TEXAS

To get the advantages that only 54 years of engine

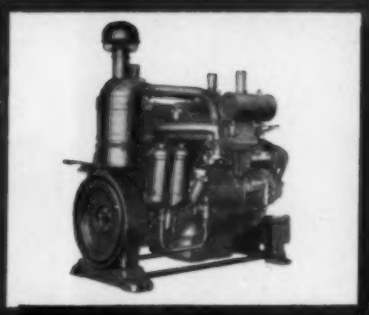
standardize on International®

Here are 5 typical members of the International family of 18



U-169

UD-350



UD-525

U-169, rugged 4-cylinder 48.6 hp valve-in-head carbureted unit, delivers top performance on "regular" gasoline. Can be adapted to burn LPG, natural gas, kerosene, or distillate. Ideal for compactors, ⅜-yd excavators, water well drills, fork lifts, rotary snow plows, 12 to 15 kw generators.

UD-350, 4-cylinder diesel develops 78.5 bhp as an engine, 75 bhp as a power unit shown above. Available in air compressors, bucket loaders, asphalt mixers and driers, ½-yd shovels and cranes, portable screening plants, 25 to 40 kw generators, hoists, graders, pumps, and trenchers.

UD-525, 6-cylinder, 121 bhp diesel with all-weather push-button starting as standard equipment. Available with 14 major attachments, including 43-gal fuel tank, muffler, skid-type subbase. Fits 29 different excavators, graders, compressors, other construction tools.

International power units in various modifications are engineered to team with all these machines:

Shovels, Cranes, Draglines
17 Manufacturers

Crushers
5 Manufacturers

Motor Graders
5 Manufacturers

Fork Lifts
3 Manufacturers

Air Compressors
5 Manufacturers

Generators
5 Manufacturers

Road Rollers
4 Manufacturers

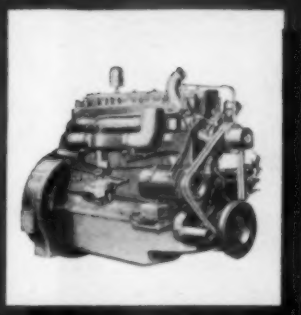
Trenchers
3 Manufacturers

Asphalt Mixers and Pavers
6 Manufacturers

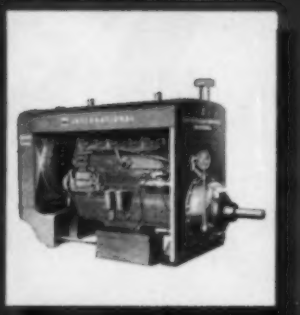
Pumps
12 Manufacturers

leadership can give . . .

Engines



U-450



UD-1091

U-450, one of the most popular 6-cylinder carbureted engines on the market today for trucks, water well drills, 35 to 50 kw generators, graders, ¾-yd shovels and draglines, big rotary snow plows, ditchers and trenchers. Develops 118.5 belt horsepower.

UD-1091, diesel, largest of the 18 International engines, develops 214 bhp, provides exceptional fuel economy for 34 different makes of construction units, including 2 to 2½-yd shovels, 8-cylinder compressors, large asphalt plants and 75 to 100 kw generators.

Engine Model	Displacement (Cubic Inches)	Horsepower (with full equipment less fan)
CARBURETED ENGINES		
U-1	60	17 @ 2500
U-123	123	31.2 @ 2000
U-169	169	48.6 @ 2000
U-264	264	53.5 @ 1600
U-220	220	64 @ 2400
U-240	240	66.5 @ 2400
U-282	282	79 @ 2400
U-372	372	96.5 @ 2200
U-406	406	104 @ 2200
U-450	450	118.5 @ 2200
U-1091	1091	214 @ 1600

Engine Model	Displacement (Cubic Inches)	Horsepower (with full equipment less fan)
DIESEL ENGINES		
UD-264	264	57.5 @ 1800
UD-350	350	78.5 @ 1800
UD-14A	461	100 @ 1800
UD-525	525	121 @ 1800
UD-140-D	525	141 @ 2300
UD-18A	691	131.5 @ 1600
UD-1091	1091	214 @ 1500

In most fields, you'll probably agree, you get the most for your money from the company that's been a leader *for the longest time.*

In engines and power units, the outfit to turn to for longest leadership is International. Since starting manufacture in 1902, International has built and sold *millions of engines* for heavy-duty work! In these 54 years, International has pioneered in developing and perfecting many of the features you consider essential today. Valve-in-head design . . . all-weather diesel starting . . . replaceable cylinder sleeves . . . tocco hardening . . . lubrication through drilled passages . . . precision type bearings . . . full-flow oil filters, to name a few.

These cost-cutting features are backed up with such added advantages as:

Honest horsepower ratings at speeds you can use.

Easy installation with attachments to fit whatever jobs you have.

Fully-experienced sales engineers to help you select and install the engine which best does your work.

Unmatched adaptability, with the same basic engine available as regular or optional power with various modifications in many kinds of equipment (one typical International engine, for instance, fits an International crawler tractor *and 46 makes* of loaders, compressors, asphalt mixers, pavers, excavators, generators, pumps, graders, and rollers). When you power with International, this ready adaptability lessens your parts inventory . . . simplifies and speeds operator training . . . makes your servicing problems a lot easier!

International engine owners get another tremendous benefit, too. To help them is one of the most experienced heavy-duty engine parts and service organizations in the world. At your service are 11 giant regional *parts depots*, 173 Industrial Power *Distributor* locations, *and* hundreds of Power Unit *Dealers*.

To get all these big profit-making advantages, be sure to specify International power. See your nearest Distributor or Dealer for all the facts.

INTERNATIONAL HARVESTER

International Industrial Power

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A COMPLETE POWER PACKAGE INCLUDING: Crawler, Wheel, and Pipe-Boom Tractors . . . Self-Propelled Scrapers and Bottom-Dumps . . . Tractor and Rubber-Tired Loaders . . . Diesel and Carbureted Engines

New! The Sherman Major Power Digger

with Many Advanced Features to Increase Versatility and Earning Power

The all new Sherman Major Power Digger has been engineered to take full advantage of the ruggedness and economy of the Fordson Major Diesel Tractor. This heavy-duty unit will dig 12 feet below grade, reach 18 feet 5 inches behind the tractor rear axle, dig throughout a swing arc of 180° and will carry a full bucket to a height of 8 feet 8 inches for loading trucks.

Additional features of the new Sherman Major Power Digger include twin crowd cylinders, heavy steel plate construction, large diameter hinge pins, heavy steel castings, replaceable hardened steel bearings at hinge points, and a newly designed dipstick, boom, cylinders, bucket and sub-frame assembly.

Write for bulletin No. 1641.

See the Sherman Major Power Digger soon at your local **FORD TRACTOR DEALER**

Sherman
PRODUCTS, INC.
ROYAL OAK, MICHIGAN
POWER DIGGERS* • FRONT END LOADERS • FORK LIFTS

*Designed, Engineered and Manufactured jointly by Sherman Products, Inc., Royal Oak, Michigan. Wain-Roy Corporation, Hubbardston, Mass.

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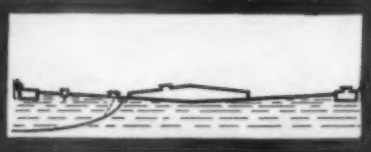
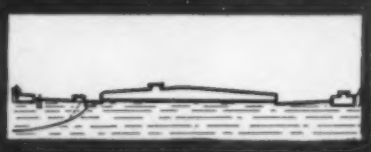
All types of Floating Roofs



WIGGINS HIDEK*

This is the natural design for storage of volatile products. A variable volume of vapor trapped beneath the steeply-pitched, quick-draining deck adds to its efficiency.



WIGGINS LODEK*

Designed so that the underside is in complete contact with the liquid surface. No vapor space can exist beneath the floating roof. Especially recommended where corrosive products are stored.

WIGGINS DOUBLEDEK*

If you prefer a double-deck roof choose the best—the new Wiggins Doubledek. Complete drainage design and between-deck accessibility add up to unmatched efficiency and safety.

WIGGINS FLOATING ROOFS PAY FOR THEMSELVES

Whatever your Floating Roof requirements get General American's UNBIASED analysis. Unbiased because General American makes ALL types of Floating Roofs!

Wiggins Floating Roofs, Dry Seal Gasholders, Lifter Roofs, Cone Roofs

*patented

WIGGINS VAPOR SEALS GENERAL AMERICAN TRADE MARK

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Financing from the **FIRST** *in Dallas goes where you go!*

Mr. and Mrs. O. D. Alsabrook, son Roger (left) and friend, are shown on drilling site of Alsabrook #3, Gaines County, Texas. Mr. Alsabrook is a long-time customer of First National's Oil Department.

- Straight collateral loans on oil or gas producing properties, secondary recovery, refining plants, pipe lines and progressive loans.
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Member Federal Deposit Insurance Corporation

put FIRST financing in your own oil future

why run a risk with Question-Mark fittings

Is the manufacturer a piping specialist?
Can he help us in engineering?
How about his experience and reputation?
Is his stock available nearby?
Does he have a complete line?
Do fittings meet all required standards?
Will fittings stand up in service?
Are dimensions true, circularity accurate?
How about their strength?
Are fittings permanently marked with complete identification?

No unanswered question...no risk
when you buy known fittings

YOU SAVE purchasing time and avoid trouble later on when you buy TUBE-TURN* Welding Fittings and Flanges. Made in U.S.A. by the leader in the field, these products give you top quality and uniformity, backed by unmatched engineering service and nearby complete-line distributor facilities. They meet *all* American Standard and Safety Code requirements. Each product is permanently identified by the "TUBE-TURN" trademark with complete size and material designation. You can't get a better bargain in welding fittings and flanges than from your trusted Tube Turns' Distributor!

The Leading Manufacturer of Welding Fittings and Flanges

TUBE TURNS LOUISVILLE 1, KENTUCKY

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POSITIVE IDENTIFICATION

THE WELDER KNOWS he's getting the exact fitting specified on the blueprint because the fitting is clearly marked with all designations.

Complete...Permanent Identification!

THE STOREROOM WORKER KNOWS he is selecting the right fitting when it's marked "TUBE-TURN". The fitting bears complete information called for on the requisition.

THE DESIGNER KNOWS that his specifications will be carried out precisely where his drawings call for "TUBE-TURN products". At every stage . . . from purchasing to pipe installation, people KNOW what they're getting and using.

CLEARLY MARKED. TUBE-TURN® Welding Fittings are completely identified as to dimensional and metallurgical facts. Here is your assurance that you have the RIGHT fitting, and that it has passed Tube Turns' rigid inspection and quality control.

This is just *one* reason why you should specify the leading brand of fittings and buy from your trusted Tube Turns' Distributor.

TUBE-TURN Welding Fittings and Flanges are made in U. S. A.
They meet *all* U. S. piping code specifications.

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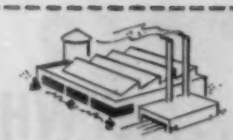
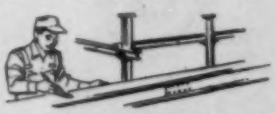


PROVED THROUGHOUT INDUSTRY FOR OVER THIRTY YEARS

Industrial leaders all over the world have used Rust-Oleum to stop and prevent rust for over thirty years. Rust-Oleum can do the same for your tanks, stacks, pipes, machinery, metal sash, wire fences, girders, etc.

RUST-OLEUM IS EXCLUSIVE

Rust-Oleum uses a specially-processed fish oil vehicle that penetrates rust to bare metal, dries right, and is free from objectionable odor. Accept no substitutes. Buy—and specify Rust-Oleum. You'll be happy that you did. There is only one Rust-Oleum—it is distinctive as your own fingerprint.



APPLY DIRECTLY OVER RUSTED SURFACES

Just scrape and wirebrush to remove rust scale and loose rust—then brush Rust-Oleum 769 Damp-Proof Red Primer right over the remaining rust, usually eliminating costly surface preparations. Then—follow-up with your desired Rust-Oleum finish color.

MANY COLORS, INCLUDING ALUMINUM AND WHITE

You beautify as you protect, because Rust-Oleum finish coatings are available in practically all colors, including aluminum and white. They use the same basic rust-inhibiting vehicle as Rust-Oleum 769 Damp-Proof Red Primer and so provide double protection.

GREATER COVERAGE—EASY TO USE

Rust-Oleum is so easy to apply by brush or spray that one man can often do the work of two. Because of Rust-Oleum's easy-flowing qualities, an average of 30% more coverage is usually received—depending upon the type and porosity of the surface.

PRACTICAL ANSWER TO YOUR RUST-PRODUCING CONDITIONS

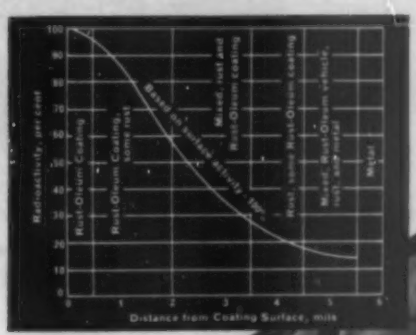
Rust-Oleum dries to a firm, decorative finish that resists salt water, heat, fumes, sun, steam, humidity, and weathering. Whatever your rust problem—you'll find Rust-Oleum the modern, practical way to stop rust.

Facts

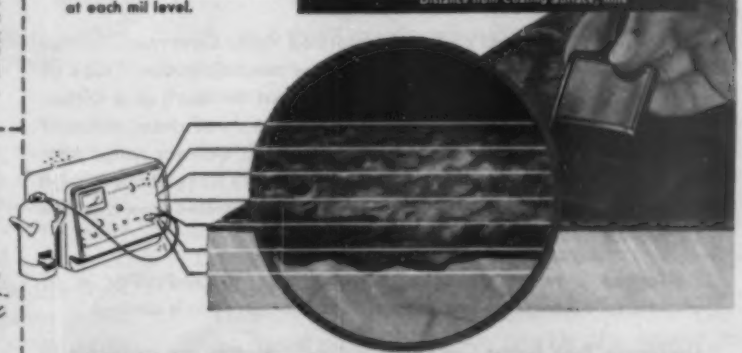
prove the economy of

RUST-OLEUM®

Geiger Counter traces Rust-Oleum penetration through rust to bare metal. The results of radioactive research prove that Rust-Oleum penetrates rust to bare metal. Rust-Oleum's *specially-processed* fish oil vehicle was radioactivated and formulated into Rust-Oleum 769 Damp-Proof Red Primer—then applied to rusted test panels. Geiger Counters then traced Rust-Oleum's *specially-processed* fish oil vehicle through the rust to bare metal. This penetration enables Rust-Oleum to be applied directly over sound rusted surfaces—usually eliminating costly surface preparations. Attach coupon to your business letterhead for your thirty-page report, "The Development of a Method To Determine The Degree of Penetration of a Rust-Oleum Fish-Oil-Based Coating Into Rust On Steel Specimens," prepared by Battelle Memorial Institute technologists.



Curved chart line shows Geiger Counter recordings of Rust-Oleum penetration at each mil level.



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STOPS RUST!

See our Catalog in SWEETS, or write for complete information. Prompt delivery from Industrial Distributor stocks.

ATTACH TO YOUR LETTERHEAD—MAIL TODAY!

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2554 Oakton St.,
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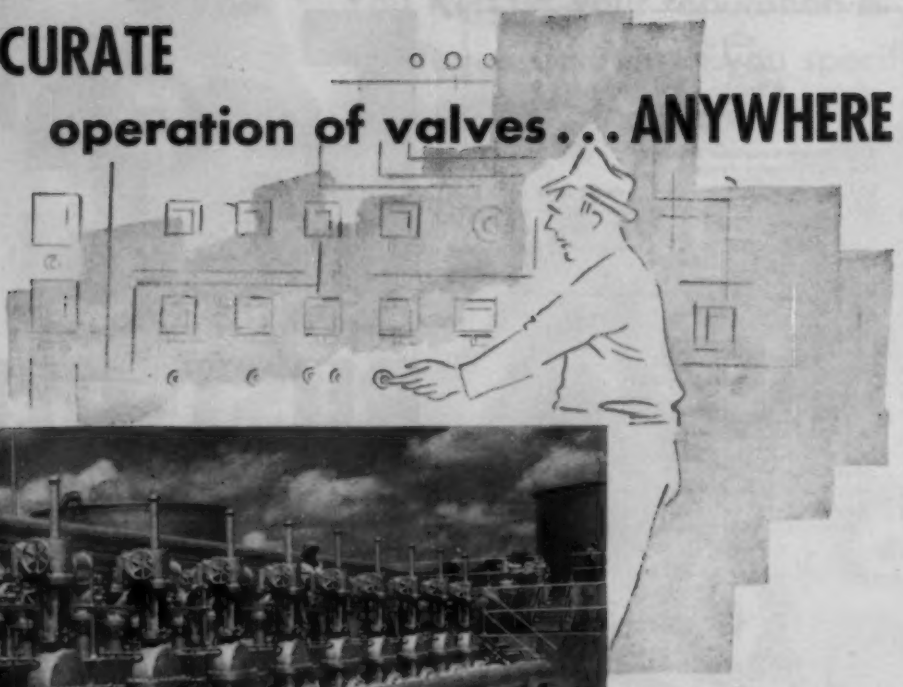
- ☐ Complete literature with color charts.
- ☐ Thirty-page report on Rust-Oleum penetration.
- ☐ Nearest source of supply.

RAPID, ACCURATE operation of valves . . . ANYWHERE



. . . assured with LIMITORQUE VALVE CONTROLS

LimiTorque . . . the world's leading motorized Valve Operator—controls flow of crude oil at this Shreveport mainline pumping station. Crude oil moves from delivery pipes to storage tanks at the touch of a button. From a central control panel, the engineer opens and closes scores of widely scattered line valves . . . controls flow and delivery rates, *automatically*. Opening and closing travel of each valve is regulated through limit switches. Valve seats, stems and discs are protected from damage by pre-set torque limit controls.

LimiTorque provides simplicity, economy and dependability in all climatic conditions wherever automatic valve operation is desired.

LimiTorque Push Button Controlled Valve Operators are available to control valves of all sizes and types—including gate, plug, globe and butterfly—in almost any position or location. Also existing valve installations can readily be adapted to LimiTorque controls.

Insist upon LimiTorque — for outstanding performance. Send for latest 32 page Catalog #L-550, on your letterhead please.

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Industrial Gears & Speed Reducers

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Established 1892

Four Le Roi L3460 engines in a pipeline station owned by a major oil company. Three of them have been in continuous operation for six years. None have undergone a major overhaul.

Power-Packed Pipeline Station

. . . uses Le Roi L3460's to provide plenty of low-cost pumping power

Le Roi's L3460 with 600 max. hp. and its bigger brother, the L4000 with 655 max. hp., are ideal for pipeline service on many counts. Here's why:

Plenty of power with good fuel economy—These engines develop 600 and 655 max. hp. with rock-bottom fuel consumption, and can be run on natural gas, gasoline, or butane. Advanced design manifolding, low friction bearings, and low power loss to accessories, all contribute to unusual operating economy.

Long engine life—Perhaps the best proof of this statement is found in the trouble-free performance experienced by users in installations like the one shown above. Basically the L3460 and L4000 are compact, high-output engines designed with short stroke to give you greater horsepower and speed, without compromising engine life. And that's exactly what they do for you.

More comfortable operating conditions—Water-cooled exhaust manifold cuts down engine heat in operating areas, yet provides fast engine warm-up. The smooth, clean lines of these engines prevent dirt from collecting —that's why they are so easy to keep clean.

Compact V-12 design packs a lot of horsepower in a small space—to give you more horsepower per dollar. This, plus vibrationless performance, reduces foundation costs, simplifies installation.

We think that if you see an L3460 or L4000 in operation you'll agree that they provide the answer to low-cost pumping power. Have your supply house or Le Roi distributor show you one at work. Bulletins are available upon request—just write us.

P-140

LE ROI *Division of Westinghouse Air Brake Co.*

Milwaukee 1, Wisconsin

PORTABLE AIR COMPRESSORS · TRACTAIR · STATIONARY AIR COMPRESSORS · AIR TOOLS · ENGINES

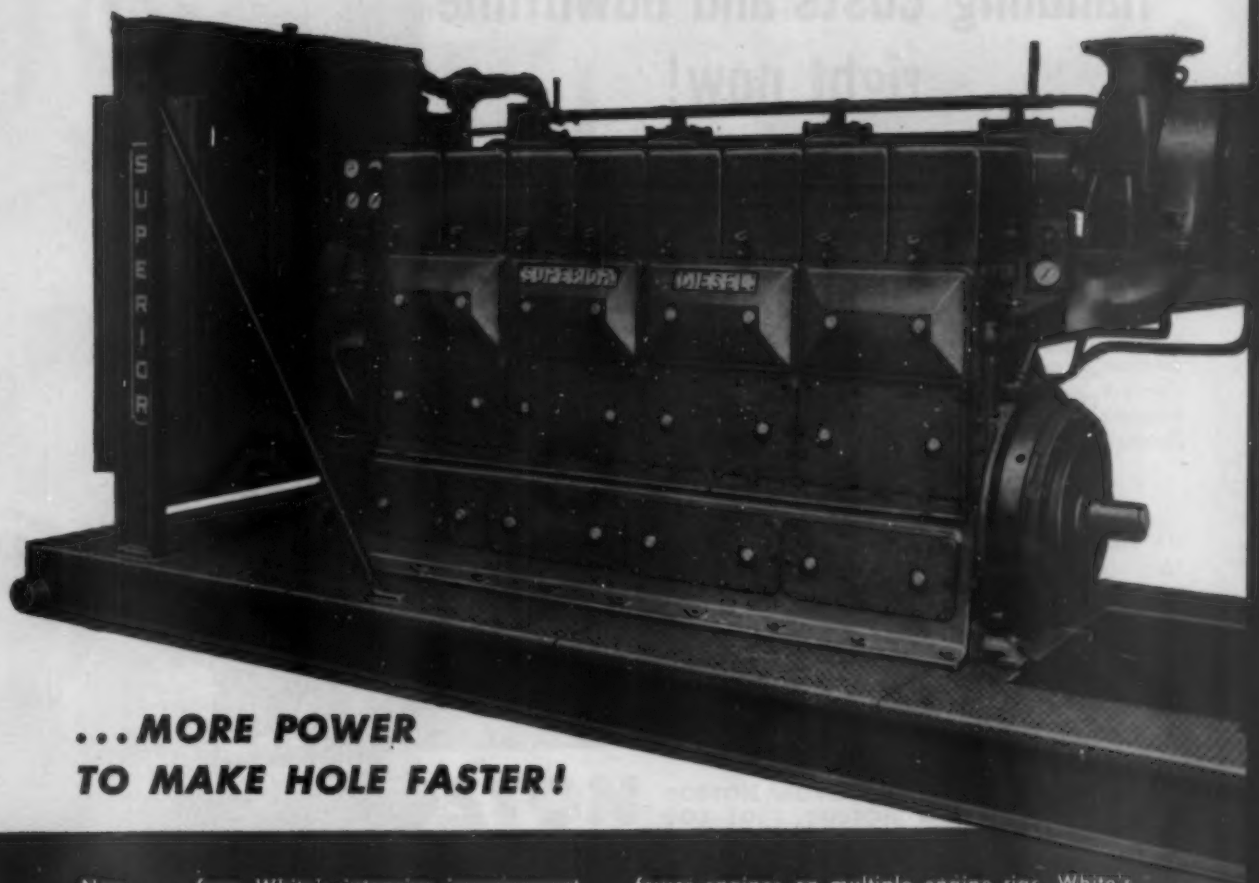
We're really excited!

CONTINUOUS WORKING HORSEPOWER*

MODEL NO.	OLD H.P.	NEW H.P.	APPROX. INCREASE
Super PTD-6	280	364	30%
Super PTD-8	375	485	29%
Super PTDS-6	460	560	22%
Super PTDS-8	620	750	21%

* Maintaining Superior's conservative rating, including fan and all other accessories. Continuous, at 900 RPM. No correction necessary to 1500 feet elevation and 90°F.

...WHITE'S NEW SUPER PTD gives you 30% MORE POWER!



...MORE POWER TO MAKE HOLE FASTER!

Now . . . from White's intensive improvement program come the newest, most highly developed Superior Diesel heavy duty drilling engines with up to 30% more power, and virtually no increase in size . . . resulting in less weight and less cost per horsepower! They give you greater working ability than ever before . . . more lugging power for easier hoisting, and faster acceleration for quicker round trips. They'll "loaf" along with plenty reserve power for emergencies. This also means you can get more power from fewer engines on multiple engine rigs. White's new design and engineering advances have also achieved even greater dependability, smoother operation, increased engine life, lower operating and maintenance costs, and highly improved engine efficiency.

All the new features of the Super PTD (naturally aspirated) and Super PTDS (supercharged) engines are described in Bulletin, 105 . . . available now at supply stores of leading rig manufacturers, or write to the Springfield office.

WHITE DIESEL ENGINE DIVISION

THE WHITE MOTOR COMPANY *Plant and General Offices: Springfield, Ohio*

Superior ENGINES ATLAS Imperial DIESEL ENGINES White DIESEL

READ WHY SO MANY ENGINEERS AND FIELD MEN SPECIFY BOSTON HOSE AND BELTING

How to slash handling costs and downtime right now!

FROM THE MOMENT SPUDDING STARTS until the end product reaches the consumer, breakdowns chop profits and waste time. To avoid these headaches, many engineers specify Boston hose and belting. They've discovered Boston products handle the toughest jobs—turn in reliable performance on every job.

BUT THAT'S ONLY NATURAL! Boston *specializes* in rubber products for industrial use. And because it isn't just a sideline, Boston has only one aim: to continue developing products that dollar-for-dollar outperform all others.

FAST DELIVERY WHEN YOU NEED IT, is next in importance after good performance. Your Boston distributor knows that. He keeps a supply of Boston hose and belting ready to meet your needs. And he knows your problems as well as he knows industrial rubber products. That's why he's your Boston Man! Call him today.

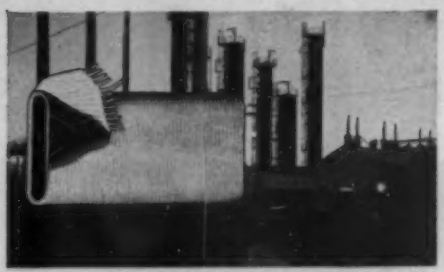
BOSTON HEAVY DUTY OIL HOSE: For loading and unloading tankers and barges. Boston has a full line of oil suction and discharge hose—all time-tested, proved sturdy. Boston hose is furnished with built-in steel or duralumin nipples. Get full details from your Boston Man.

INDUSTRIAL HOSE • FIRE HOSE • BELTING

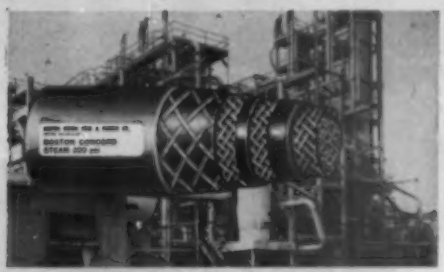
BOSTON CHECKLIST FOR YOUR HOSE AND BELTING REQUIREMENTS

BOSTON TANK TRUCK AND FUEL OIL HOSE: Boston's seamless, synthetic tube won't flake or soften because it is unaffected by gasoline, oil, and other fuels. That means more rapid fuel transfer under all conditions. Your Boston Man will help you select the right hose for your jobs.

BOSTON V-BELTS: Muscles of tough, special cord brace *all* Boston V-Belts against slippage and shock loads. That's why they require less maintenance than other belts, deliver power more smoothly, efficiently and economically. Get the right belt for your job from your Boston Man.



BOSTON CHEMICAL AND FIRE HOSE: Boston's complete line of chemical and fire hose lasts longer even under the toughest conditions. That's because every Boston hose is designed for a specific job, engineered to do that job more effectively. Put Boston hose to work to protect your plant!



BOSTON STEAM HOSE: Built with safety to spare, Boston Steam Hose eliminates breakdowns and handling problems on cleaning and maintenance jobs; Boston's complete line of wire-reinforced and wrapped fabric steam hose is made with time-tested, heat-resistant compounds.

BOSTON SERVICE STATION HOSE: Air hose and gasoline Curb Pump hose used in service stations must absorb rough handling, weather, dirt, grease. Boston hose is designed to take this kind of punishment. There's a full line of Boston maintenance hose for air, water and steam applications.

BOSTON Specialists

BOSTON WOVEN HOSE & RUBBER CO.
BOX 1071, BOSTON, MASS.

IN INDUSTRIAL RUBBER PRODUCTS

NEW PURCHASING GUIDE
FREE! Now—right at your fingertips—all the facts you want to know about the rubber products you use. Saves you time and money; helps you get the right equipment in a hurry. Mail coupon today!

Boston Woven Hose & Rubber Company
Box 1071, Boston, Massachusetts
Rush me a free copy of your petroleum rubber products purchasing guide.

Name_____

Company Name_____

Address_____

City_____ Zone____ State_____

• V-BELTS • PACKING • TAPE

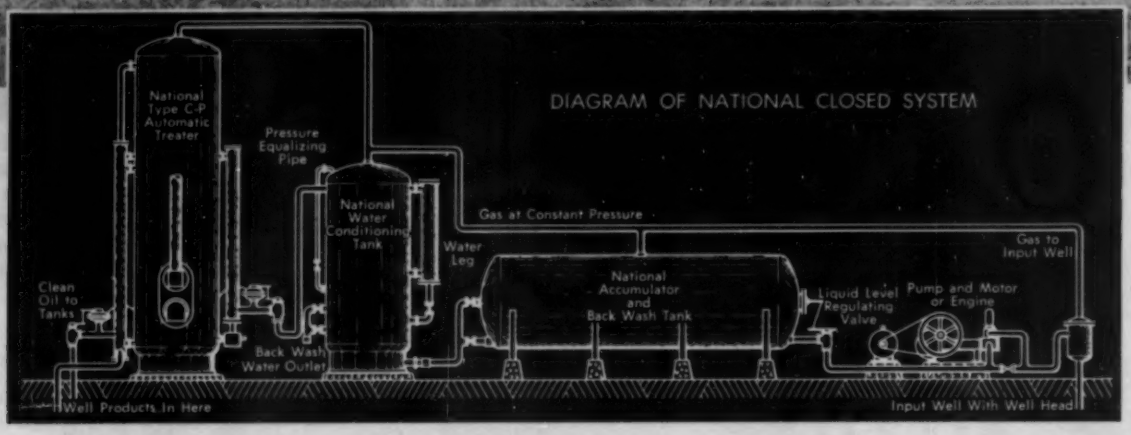


DIAGRAM OF NATIONAL CLOSED SYSTEM
National Type C-P Automatic Treater
Pressure Equalizing Pipe
National Water Conditioning Tank
Gas at Constant Pressure
Water Leg
Gas to Input Well
Clean Oil to Tanks
National Accumulator and Back Wash Tank
Liquid Level Regulating Valve
Pump and Motor or Engine
Back Wash Water Outlet
Well Products In Here
Input Well With Well Head

NATIONAL CLOSED WATER DISPOSAL SYSTEMS

. . . used for Pressure Maintenance

National Water Disposal Unit, Wesson Field, near Stephens, Arkansas.

2 10′ x 20′ horizontal accumulator and backwash
2 10′ x 20′ vertical conditioners
1 10′ x 5′ filter
1 2IF separator (used as gas scrubber)

NATIONAL ALL THE WAY!

Field opened January, 1946 — Bottom Hole Pressure 1299 PSI.

On July 1, 1948, BHP had dropped to 412 PSI. Water injection began September 1, 1948.

To date, 36,758,358 bbls. of water have been returned to the formation and BOTTOM HOLE PRESSURE IS NOW 1357 PSI — 58 PSI GREATER THAN ORIGINAL PRESSURE.

Oil Production to date — 17,571,999 bbls.

Our Engineering Department welcomes inquiries concerning your water disposal problems.

It's a National®

NATIONAL TANK COMPANY

TULSA, OKLAHOMA

THE O·C·T C-20 CASING HEAD

lets you work in *Safety*

Regardless of how or when you decide to install the O-C-T "C-20" Casing Hanger . . . before cementing, after cementing, through preventers, under preventers, or at any time in case of stuck pipe . . . you can improve the safety of your completion operations and save hours of expensive rig time due to the flexible, simplified O-C-T installation procedure.

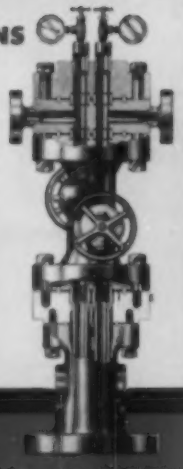
Let your O-C-T Representative give you all the details or write for complete information. Available through more than 700 supply store locations.

The first quick-setting, positive-sealing well head designed especially to eliminate open hole hazards in medium depth wells, the O-C-T "C-20" Casing Hanger can't forget to seal . . . because the sealing element, slip bowl and slips are assembled as a single unit that may be wrapped quickly around the casing, latched and dropped into place, eliminating the possibility of individual parts being installed incorrectly.

FOR DUAL COMPLETIONS
Specify
O·C·T

This compact Oil Center Tool Company Christmas Tree assembly provides a safe, strong and practical means to economical dual completions.

If you are considering dual completions, it will pay you to check the features and get the full story of this O-C-T Dual Completion Assembly.



O·C·T

OIL CENTER TOOL CO.

P. O. Box 3091, Houston, Texas

Export Representatives: Sterling Areas—Lo. Grand, Sutcliff & Gell, Ltd., Rochester, Kent, England. South America—East West Oiltools, C. A., Del Lago Hotel, Maracaibo, Venezuela. Address Export Inquiries for All Other Countries to P. O. Box 3091, Houston, Texas.

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BAY CITY
CORPUS CHRISTI
SECURITY WINS GULF COAST TEST---
--- CUTS TIME --- USES FEWER BITS
Profit by the records of these two Gulf Coast drilling contractors:*
Contractor A — Near Brenham, Texas, his rig drilled 8710 feet in 294 rotating hours — using 13 Security three-cutter bits. An offset location to same depth required 305¾ rotating hours — using 18 competitive bits.
Contractor B — Near Houston, his rig drilled 7997 feet in 150 hours — using 7 Security bits. An offset well to same depth took 208 hours, utilizing 10 competitive bits.
Small wonder that more and more drilling contractors are switching to Security. Field-proven superiority has moved Security's SALES UP FROM FIFTH TO SECOND PLACE IN THREE YEARS.
Prove to yourself that it pays to get Security in your drilling.
*NAME ON REQUEST
Security
ENGINEERING DIVISION
DALLAS, TEXAS • WHITTIER, CALIF.
Export Office: Chanin Bldg., New York, N.Y.
Security
ROCK BIT
UP FROM 5th TO 2nd PLACE IN THREE YEARS

Of Things To Come . . . In Oil

LOOK FOR CLOSER COOPERATION between independents and larger producers to fight growing legislative trend toward more and tighter federal government controls of oil industry. Justice Department's proposed investigation of the IOCC, senate investigations of oil lobby practices, numerous anti-trust suits against oil, H-F gas bill veto, threat to depletion allowance and others to bring more unity into fight against creeping "socialism."

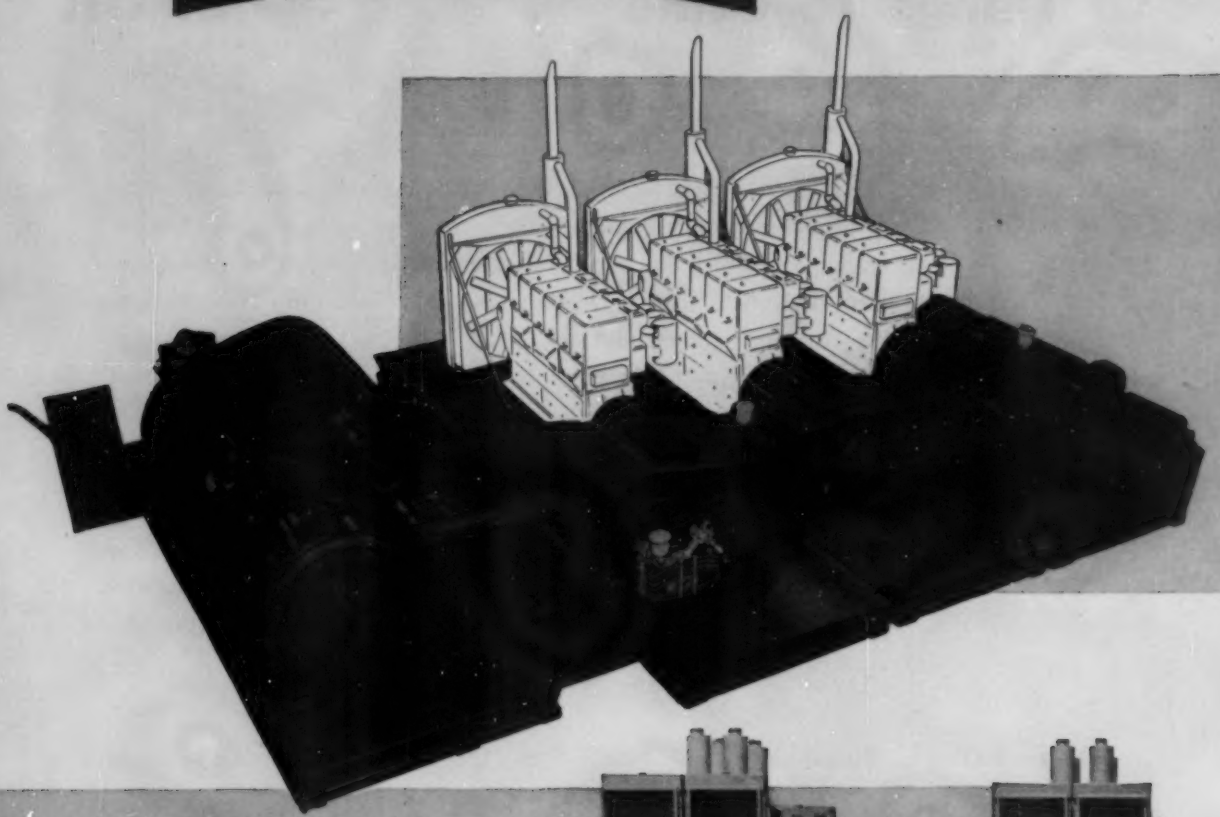
OIL STORAGE TO GO UNDERWATER in offshore fields, if current thinking and plans of some companies materialize. Economics is reason for trend. It's expensive to pipeline oil from individual fields great distances from shore. Submerged storage in area will permit continuous production even in bad storms. Idea still is under study.

DUAL COMPLETIONS TO GET BOOST in New Mexico if Sinclair's recent application is approved. Action by conservation group should open door to other valid applications. Method will offer considerable savings experienced in other states.

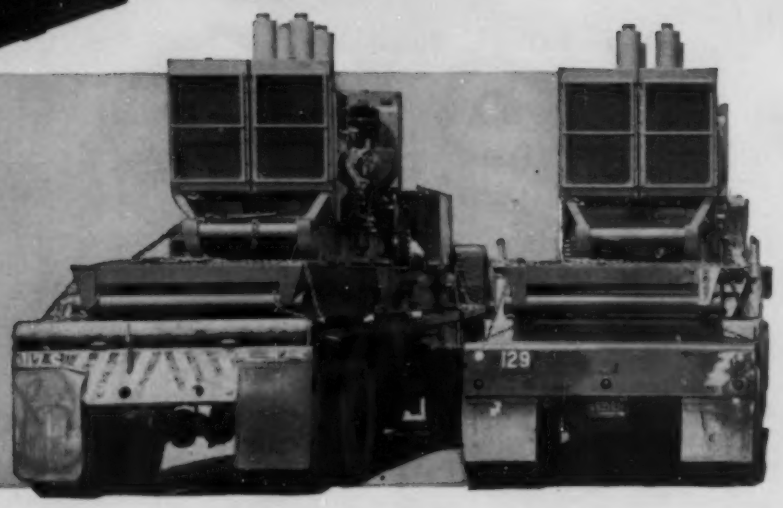
CALIFORNIA WILL GET CONSERVATION LAW if wishes of some come true. Oil and Gas Conservation Act to be submitted to voters come November. It has lots of good points, and many operators are in agreement. Allowables now on voluntary basis, but need exists to legalize steps for unitization for maximum recovery in number of fields. Legal machinery now lacking.

LOUISIANA'S ALLOWABLE BASIS IN FOR CHANGE. Conservation Commissioner John B. Hussey called for industry advisory group to recommend manner of lowering proration formula. So far, industry representatives favor an "across-the-board" percentage cut rather than altering current "depth-bracket" formula. Reason for action: too much production.

EMSCO proudly presents



Ships easily on 4 Trucks



The operator will save time with a new friction-compounding clutch between No. 1 and No. 2 engines when he operates No. 1 engine separately to drive the rotary. No time lost shifting jaw clutches when a connection is made.

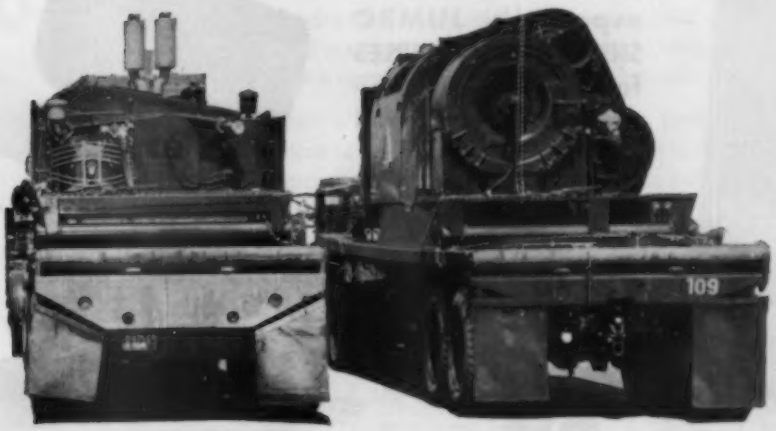
Controls are in a separate slide-mounted console which can be pulled out for use and pushed in for moving. A highly effective lubrication system with a true oil filter of the cellulose type will continuously filter about one-sixth of the oil circulated.

a-601

the new A-800 RIG

- Designed for medium to deep wells, the new EMSCO A-800 Rig fills a long felt need for greater portability in 4 packages, each of proper road dimensions, plus maximum power and economy.
- Incorporates many new and improved features. The selective transmission is in the No. 1 engine package, and the output shaft of the sectional type compound and the input shaft of the selective are one and the same.
- Can be powered by any three drilling engines having a total power output of 1,000 h.p. Engine to transmission drives may be Fawick clutch, torque converter or hydraulic coupling.
- Auxiliary brake is permanently mounted on the drawworks skid. Brake cooling system is vastly simplified, cooling more efficient, and volume far greater, with water passing through both rims in one end of the drumshaft and out the other.

For best service with the A-800 Rig, we recommend the use of EMSCO P-20½ and PJ-20½ Rotary Machines, R-44-6 Crown Blocks, R-44-5 Traveling Blocks, and L-300 Swivels.



Note how easily the EMSCO A-800 Rig can be shipped, as shown by the four convenient packages, each designed to fit on a truck. These four convenient packages can be rapidly and easily assembled.

Call CONTINENTAL for complete information on the new EMSCO A-800 Rig which offers so many advantages.

CONTINENTAL
Serving the Oil and Gas Industries

CONTINENTAL SUPPLY COMPANY
A Division of The Youngstown Sheet and Tube Company
General Offices, Dallas, Texas
Representatives in all principal oil fields of the world

EMSCO
REG. U. S. PAT. OFF.

EMSCO MANUFACTURING COMPANY
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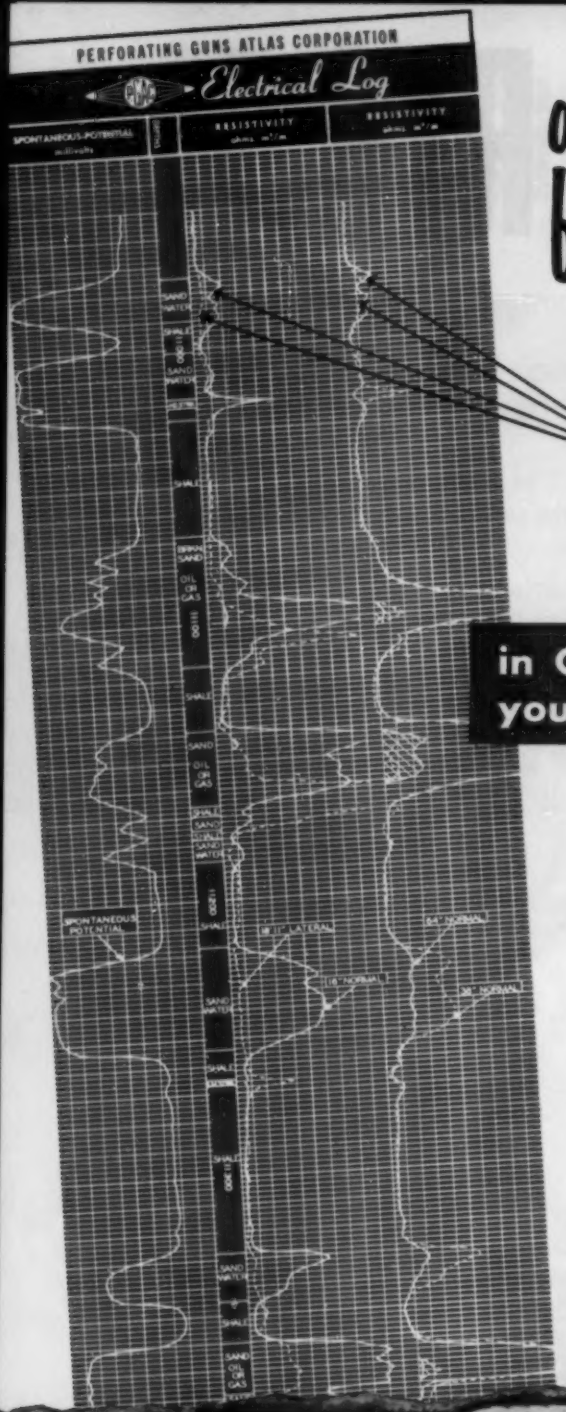

and Now... for OKLAHOMA!

PGAC's *Special* Electrical Log #3-1-1 whips Oklahoma's formations!

4 ***Yes, 4 RESISTIVITY CURVES***
3 Normal Curves and 1 Lateral Curve
ALL RECORDED SIMULTANEOUSLY
with PGAC's superior S.P. curve

5 Curves *always* give more data than 4 !

in OKLAHOMA you need PGAC

for Greatest Definition,
for Complete Record,
for Fastest Run
. . . And You Save Money!

Also, now available in Oklahoma *All Other PGAC Services*— especially JUMBO SIDE-WALL SAMPLES for unequalled recovery—even in hard formations!

7 PGAC Stations in Oklahoma Ready to Better Serve You. Write Today For Details.

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CALL FOR PROMPT SERVICE — ALWAYS READY TO SERVE YOU

TEXAS: Abilene — Alice — Beaumont — Colorado City — Corpus Christi — Dallas — Fort Worth — Gainesville — Graham Houston — Longview — Odessa — Pampa — Victoria — Wichita Falls.
LOUISIANA: Houma — Lafayette — Lake Charles — Shreveport. KANSAS: Great Bend — Liberal.
OKLAHOMA: Ardmore — Healdton — Oklahoma City — Pauls Valley — Perry — Seminole — Tulsa. NEW MEXICO: Hobbs.

AFFILIATE COMPANIES: CANADA — Perforating Guns of Canada, Ltd.; Edmonton, Alberta
GERMANY — Atlas Deutsch- Amerikanische Olfelddienst G. m. b. H.; Kiel VENEZUELA — Servicios Tecnicos Atlas, C.A., Caracas

the master move . .

D&S and Truco!

Oilmen the world over are making the smart move to D&S and Truco diamond equipment.

Custom-fitted for every job, D&S diamond drill bits give faster penetration and cleaner holes. D&S core bits assure core recoveries in both hard or soft formations and connection every time.

An integral part of value-received when you use D&S equipment is the D&S sales-engineer. He confers on every job and analyzes formation, depth, equipment, and operating techniques. This data determines your exact diamond requirements. Hence, a custom-fitted-bit for every job. Herein lie the real D&S advantages to you.

WRITE OR CALL TODAY!

DIAMOND CORING BITS
Fast penetration, full core recovery.

DIAMOND DRILLING BITS
More footage, less rig time.

DIAMOND WASHOVER SHOES
Fast "Fish" recovery.

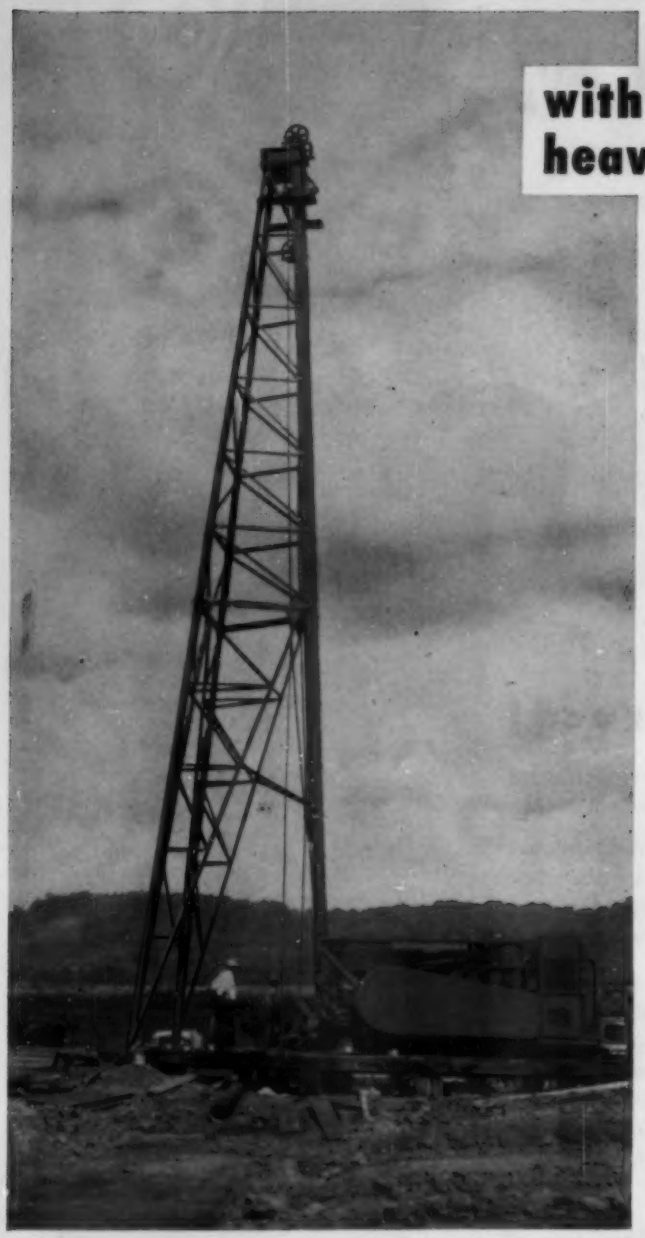
CORE BARRELS
— The standard of the industry.

TRUCO DIAMOND BITS

ULTRA FINE DIAMOND EQUIPMENT FOR THE OILFIELD
6210 NORTH CENTRAL EXPRESSWAY | DALLAS, TEXAS
OFFICES IN ALL PRINCIPAL OIL AREAS

Drilling & Service

boost casing-handling capacity, retain mobility



with 150-ton capacity heavy-duty tripod derrick

Already famous for top mobility in big capacity drills, Bucyrus-Erie 36-L and 48-L spudders can now be equipped for even greater casing-handling capacity with the addition of a heavy-duty tripod derrick. This is the *first* 150-ton derrick of this type designed especially for a spudder. Completely raised, the derrick is 70' 4" high; static load capacity is 300,000 pounds, when rigged for 10-part hoist.

Despite the size of this special derrick, you lose nothing in the way of mobility because it is surprisingly easy to set-up, tear down, and move. Here's why:

1. SIMPLE DESIGN. Derrick assembly consists of but five sections which include a special substructure, plus a gin pole used in erection.
2. EASE OF FIELD ERECTION. Sections are assembled on the ground, derrick legs hinged to base. With gin pole in place, derrick is raised to vertical position, using bull reel drum for hoisting. When the derrick is completely raised, the main front lower section swings into place. The gin pole is removed and you're ready to string tools. Lowering and dismantling is equally simple.
3. FAST JOB-TO-JOB MOVES. Moving the derrick, because of its design simplicity, is fast and easy. The entire structure can be disassembled into five separate units for moving.

The heavy-duty tripod derrick is available for 36-L's and 48-L's already in the field, or may be ordered with a new machine in place of the regular derrick. For all the details, see your local Bucyrus-Erie distributor.

19555

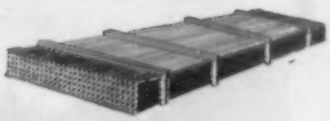
BUCYRUS-ERIE COMPANY
SOUTH MILWAUKEE, WISCONSIN

BUCYRUS ERIE

36-L
Top-to-bottom drilling to 3,500 feet
Servicing to 4,000 feet
Swings up to 4,200 pounds of tools

48-L
Top-to-bottom drilling to 6,000 feet
Servicing to 7,000 feet
Swings up to 6,000 pounds of tools

IN HUNDREDS OF FIELDS...
the durability of Jones Sucker Rods is unmatched



THOUSANDS OF STRINGS...
are providing economical and efficient service.

ROUND THE CALENDAR SERVICE... year-after-year, trouble-free, dependable.

PROVING GROUND FOR JONES SUCKER RODS. There is no better proof than performance. In the field, Jones Sucker Rods meet and exceed every claim made for them. That's because they are designed and made by specialists...who have pioneered every major rod improvement.

JONES
SUCKER RODS

Look for the "GREEN" Rods

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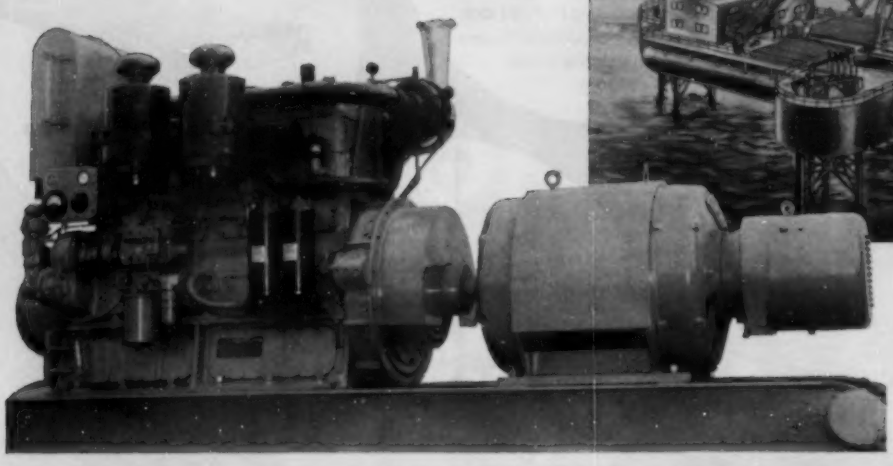
PARTNERS IN PETROLEUM PROGRESS

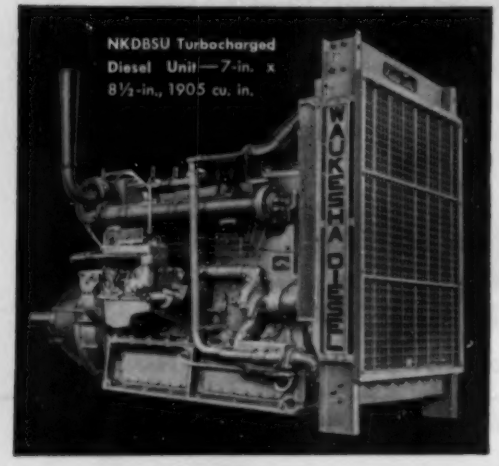
THE S. M. JONES COMPANY
Division of Buffalo-Eclipse Corporation

General Office and Factory: **TOLEDO, OHIO**
Sales Office: Kennedy Building, **TULSA, OKLAHOMA**
Export Sales Representatives: IDECO—Division of Dresser Equipment Company, Republic National Bank Building, Dallas, Texas and Chanin Building, New York City

on the ZAPATA off-shore platform



WAUKESHA *Turbodiesels* supply reliable generator power



This mobile off-shore platform of the Zapata Off-Shore Company of Houston, Texas, has two engine generator sets to supply auxiliary power. A 1200 rpm Model NKDBS Waukesha Turbodiesel powers each of these 200 KW, 3-phase, 120/208 volt generator sets which are built by the Reagan Equipment Co. of New Orleans, La.

The Waukesha NKDBS is a 6-cyl., 1905 cu. in., counterbalanced crankshaft, turbo-supercharged Diesel. A rugged, compact engine, it has lively acceleration, clean burning, prompt starting, and great overall economy. Waukesha's exhaust turbocharger system, unique patented combustion chamber, and design features proved in many years' service provide smooth, **extra** power—up to 368 hp in this NK Series Turbodiesel. Send for Bulletin 1634.

50th ANNIVERSARY Waukesha MOTOR COMPANY 1906-1956

314

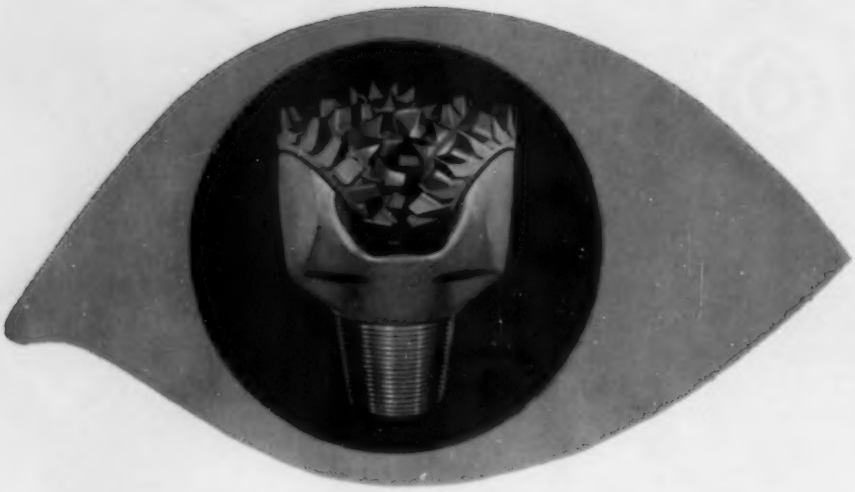
WAUKESHA MOTOR COMPANY, WAUKESHA, WISCONSIN
New York • Tulsa • Los Angeles

Hughes bits go through on schedule

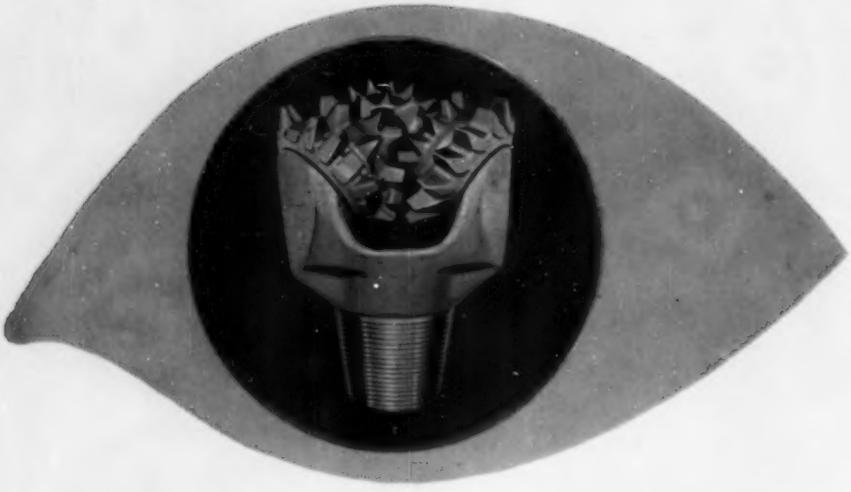
Operators know, *from long experience,* that regardless of terrain or weather, Hughes bit deliveries will be on schedule. The more than 450 members of the Hughes sales and service organization cover, *regularly,* every active drilling area in the United States and Canada.

At Hughes, however, we do more than follow the drill. Through our far-ranging representatives, working closely with the drilling industry, we determine, months in advance, the bit needs of each field and wildcat area. That's why HUGHES assures delivery of the right bits to your rig... *ahead of time!*

Fording Peace River... painted from actual photograph



THEY LOOK ALIKE ... but



there's a difference in their performance

Looks can be deceiving. Because bits look alike is no assurance they will perform alike.

Just as an example, take the two bits pictured here. What you don't see in the second bit is the increased bearing capacity and other changes that made it a more versatile, longer-lasting, better-performing bit that makes more hole.

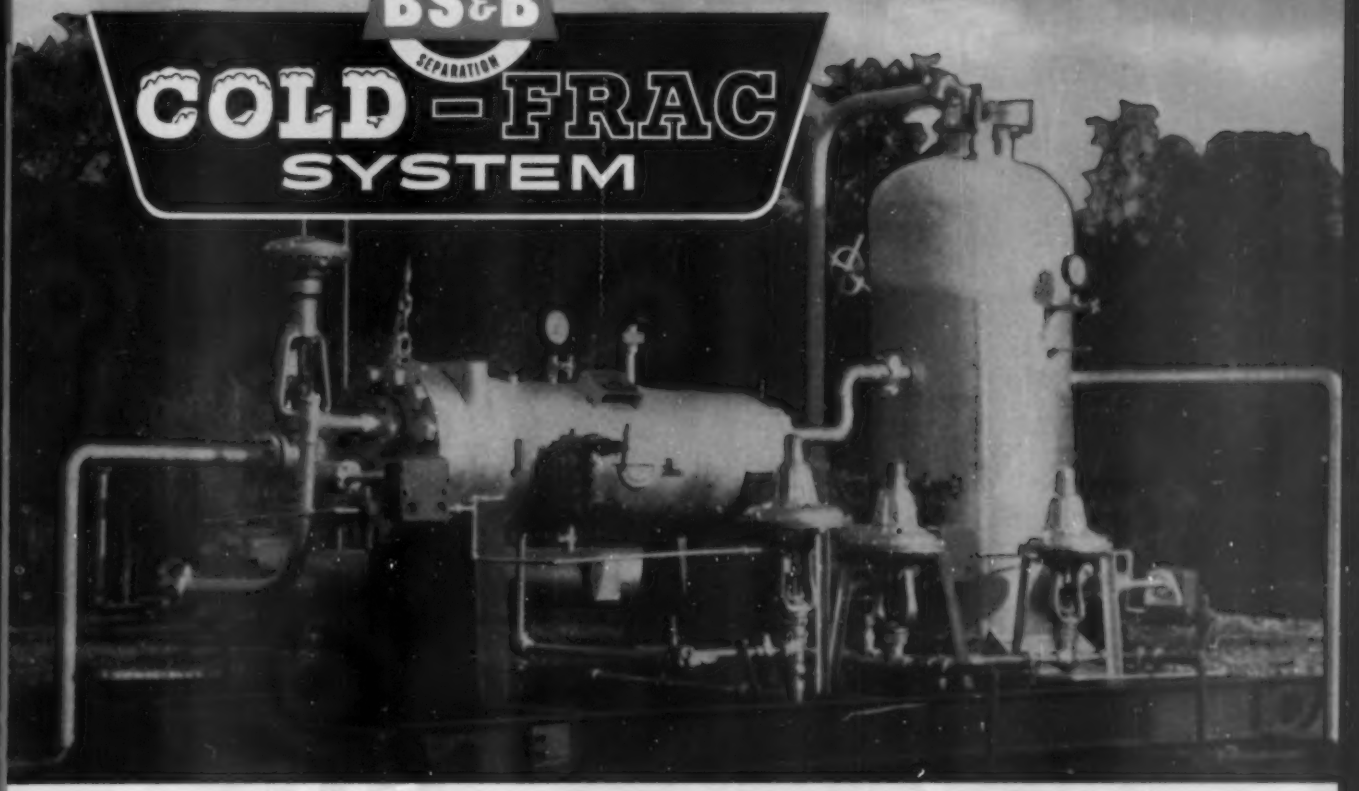
Back of the continuing improvement in HUGHES rock bits are unending research and experience gained in drilling millions of feet of hole each year in fields throughout the world.

Introducing...

The New BS&B Model MDH...

LOW TEMPERATURE BS&B SEPARATION

COLD-FRAC SYSTEM



Compactly Skid Mounted And Ready For Hook-Up!

The new BS&B Model MDH COLD-FRAC System is a completely packaged unit designed for service on high pressure gas condensate wells. Requiring only four field connections, it is available either with or without a second stage separator. Unsurpassed for economy, performance and freedom from operational troubles. Provides maximum return on your investment!

FEATURES

1. Designed For Optimum Recoveries Through Lower Temperatures.
2. Higher Separation Efficiency.
3. Reduced Operating Problems.
4. Less Space Requirements.

Your BS&B Representative Will Gladly Supply You With Detailed Information On The New BS&B Model MDH COLD-FRAC Unit, Or You May Write To...

BLACK, SIVALLS & BRYSON, INC.

Oil & Gas Equipment Division, Dept. 1-C5

1708 West Main Street Oklahoma City, Oklahoma

OVER 60 YEARS BS&B RELIABILITY

ANOTHER EXAMPLE OF PRODUCT LEADERSHIP

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HYDRAULIC JACKS BUILT BY

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HOUSTON 21, TEXAS
Box 14471 — Phone JA 8-0591

Specialists in custom-designed, hydraulic jacks — offshore and big-rig equipment.

*THIS TONNAGE WAS ENGINEERS' FIGURE ON RIG-WEIGHT OF SALT DOME PRODUCTION CO. RIG NO. 10.

CSCO

PUMPING ENGINES

...wherever Oil is produced!

Whether Operating at High or Low Temperatures — Extremely Dry or Humid Conditions — CSCO Pumping Engines Need No Modifications or Special Equipment.

Only CSCO Engines have ALL 4 of these important features:

EASY AND SAFE TO START... A flip of release cam and flywheel momentum rides through the compression of combustible mixture. This is possible because the simple hand control cam holds inlet valve open (not exhaust valve), thus releasing compression. Therefore, the combustible mixture is allowed to charge the cylinder during free cranking.

SMOOTH, STEADY OPERATION... Flywheel inertia provides peak power while oil damped governor holds throttle steady — permitting engine to average demand, up to full capacity.

EASY TO SERVICE... There's no need to stop a CSCO to check or add oil... or water. Less shutdown for servicing.

EASY TO REPAIR... CSCO parts needing repair or attention can be removed with a minimum of disturbance of adjacent parts or assemblies.

CSCO Pumping Engines are available through supply stores other than Continental.

CONTINENTAL

Serving the Oil and Gas Industries

CONTINENTAL SUPPLY COMPANY

A Division of The Youngstown Sheet and Tube Company

General Offices: DALLAS, TEXAS

Representatives in All Principal Oil Fields of the World

The Petroleum Industry... Since 1859 Helping Make America Great

. . . the members of

They were ready YESTERDAY

. . . ready to drill the first oil well with little in the way of equipment, but much in the way of resourcefulness.
Venturesome men, who wanted hard jobs that would test their ingenuity, naturally gravitated to this challenging task. They adapted equipment from other industries and a blacksmith made their bits and special tools. Only their bulldog determination enabled them to carry on in the face of difficulties that would discourage the less hardy.

They were rewarded for their never-say-die spirit by striking oil at 69½ feet. Thus was born the famous Drake well near Titusville in Pennsylvania in 1859.

This was the beginning of a new name for this type of man, who thrives on doing jobs that require inventiveness, courage and the tenacity to stick to jobs that would discourage men of lesser breed — "the petroleum equipment and service supplier."

They are ready TODAY

A survey showed that petroleum equipment suppliers who are members of P.E.S.A. travel 511,000,000 service miles annually, serving the great oil industry.

9,000 ENGINEERS: Another survey showed that they have over 9,000 engineers inventing, improving equipment and furnishing technical assistance in the use of tools and services. These engineers are composed of research scientists, development engineers, metallurgists, production and inspection engineers, and field service engineers.

A MULTI-BILLION-DOLLAR PLANT INVESTMENT — the value of the combined plants of the individual P.E.S.A. members—is necessary in order to supply the giant oil industry with equipment and services—*where* wanted, *when* wanted *and in the quantities wanted.*

These and many other points prove that P.E.S.A. members are doing a superlative job . . . *TODAY.*

No matter ***when*** ...

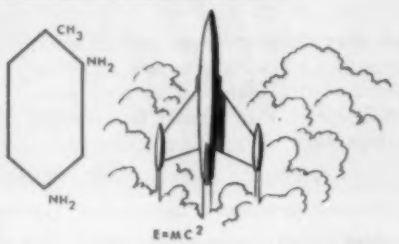
No matter ***where*** ...

No matter ***what the cost*** ...

THE OIL INDUSTRY WILL ALWAYS SAY:

P.E.S.A.* are ready"

They will be ready TOMORROW



Just as the petroleum equipment suppliers kept pace with the amazing growth from the 69½-foot Drake well to the 4-mile-deep wells of today . . . so will they keep ahead of the requirements of a fabulous future.

The predictions of scientists for the next quarter century are breath-taking: guided missiles to haul passengers to destinations within minutes after their take-off . . . thawing the Arctic and Antarctic into productive use . . . making the deserts flourish . . . greatly extending the use of nuclear physics in producing oil . . . metals and methods that will enable the drilling of wells to depths that will overshadow the progress made in the past . . .

No matter *when, where* or *what, P.E.S.A.* members will be *ready.*

P.E.S.A.*

*Petroleum Equipment Suppliers Association

Composed of: manufacturers whose plants make the finest precision equipment . . . supply stores who add two other ingredients of value — where you want it — when you want it . . . service companies who make available to their customers the practical results of the theoretical research of some of the most brilliant scientific and technical men in the world.

They were ready YESTERDAY

. . . ready to drill the first oil well with little in the way of equipment, but much in the way of resourcefulness.

Venturesome men, who wanted hard jobs that would test their ingenuity, naturally gravitated to this challenging task. They adapted equipment from other industries and a blacksmith made their bits and special tools. Only their bulldog determination enabled them to carry on in the face of difficulties that would discourage the less hardy.

They were rewarded for their never-say-die spirit by striking oil at 69½ feet. Thus was born the famous Drake well near Titusville in Pennsylvania in 1859.

This was the beginning of a new name for this type of man, who thrives on doing jobs that require inventiveness, courage and the tenacity to stick to jobs that would discourage men of lesser breed — "the petroleum equipment and service supplier."

They are ready TODAY

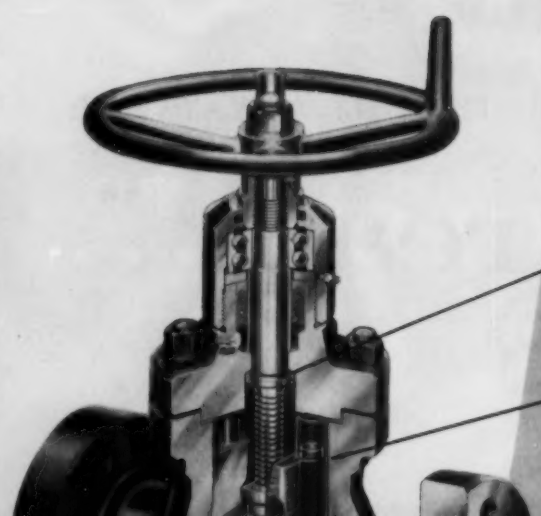
A survey showed that petroleum equipment suppliers who are members of P.E.S.A. travel 511,000,000 service miles annually, serving the great oil industry.

9,000 ENGINEERS: Another survey showed that they have over 9,000 engineers inventing, improving equipment and furnishing technical assistance in the use of tools and services. These engineers are composed of research scientists, development engineers, metallurgists, production and inspection engineers, and field service engineers.

A MULTI-BILLION-DOLLAR PLANT INVESTMENT — the value of the combined plants of the individual P.E.S.A. members—is necessary in order to supply the giant oil industry with equipment and services—*where* wanted, *when* wanted *and in the quantities wanted.*

These and many other points prove that P.E.S.A. members are doing a superlative job . . . *TODAY.*

Can you find all these features in any other valve?

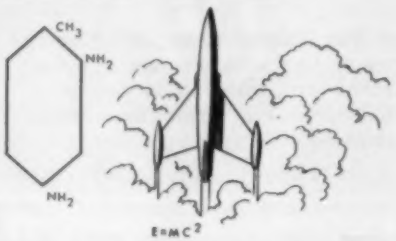


Compare these exclusive features of the McEvoy Valve with **any other valve** and see why McEvoy is always specified for the toughest, most grueling jobs.

1. **Back Seating**—McEvoy Valves can be back-seated while packings or bearings are inspected or replaced under **full pressure.**

2. **Two Large Reservoirs** in each McEvoy Valve store **clean sealing compound** (Not Lubricant) for automatic feeding to downstream sealing surfaces in response to line pressure. *Enclosed reservoirs prevent contamination of*

They will be ready TOMORROW



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P.E.S.A.*

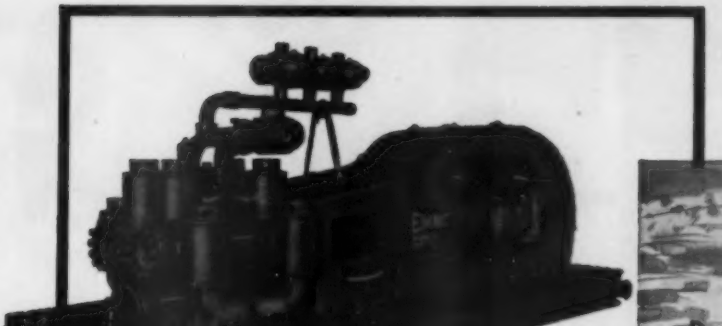
** Petroleum Equipment Suppliers Association*

Composed of: manufacturers whose plants make the finest petroleum equipment . . . supply stores who add two other ingredients of value — where you want it — when you want it . . . service companies who make available to their customers the practical results of the theoretical research of some of the most brilliant scientific and technical men in the world.

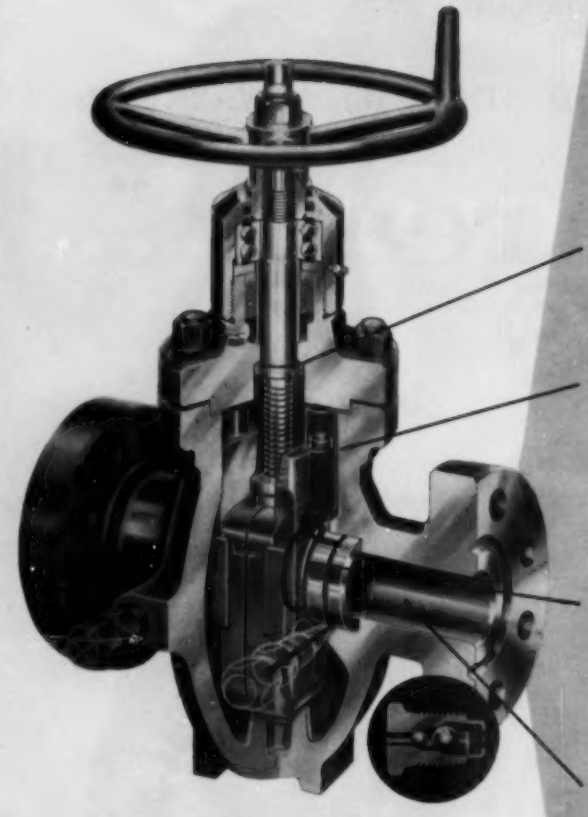
Dependable Performance • Advanced Design • Low Cost Operation

EMSCO SLUSH PUMPS

are available in sizes to meet every drilling requirement!



Can you find all these features in any other valve?



Compare these exclusive features of the McEvoy Valve with **any other valve** and see why McEvoy is always specified for the toughest, most grueling jobs.

1. **Back Seating**—McEvoy Valves can be back-seated while packings or bearings are inspected or replaced **under full pressure.**

2. **Two Large Reservoirs** in each McEvoy Valve store **clean sealing compound** (Not Lubricant) for automatic feeding to downstream sealing surfaces in response to line pressure. *Enclosed reservoirs prevent contamination of sealing compound.*

3. **Tightness**—McEvoy Valves are automatically "Gasketed" between gate and seat and between seat and body by the automatic self-sealing system which **stops leaks** the instant they start. *This "Gasketing" prevents leakage.*

4. **Two-Way Valve** assures perfect automatic sealing with pressure in either direction and installed in any position, *Safe . . . they cannot be installed backwards.*

McEvoy Valves offer years of low cost, trouble-free service. They have been **field proven** under the world's most severe conditions in thousands of installations.

Write for Valve Brochure

Patented

McEvoy COMPANY

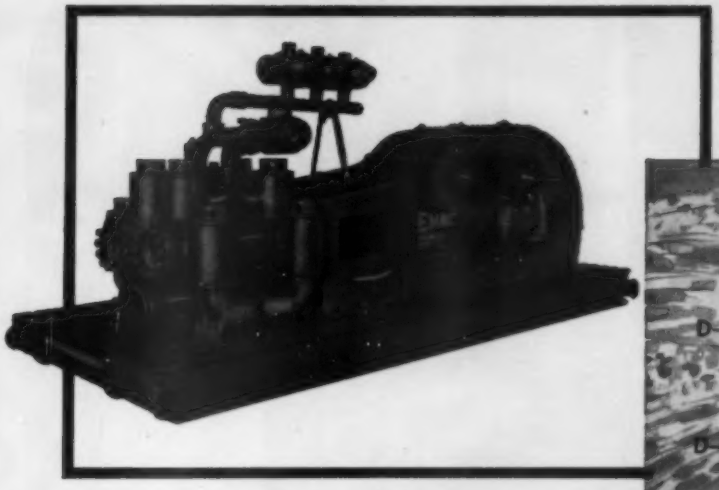
OIL WELL EQUIPMENT

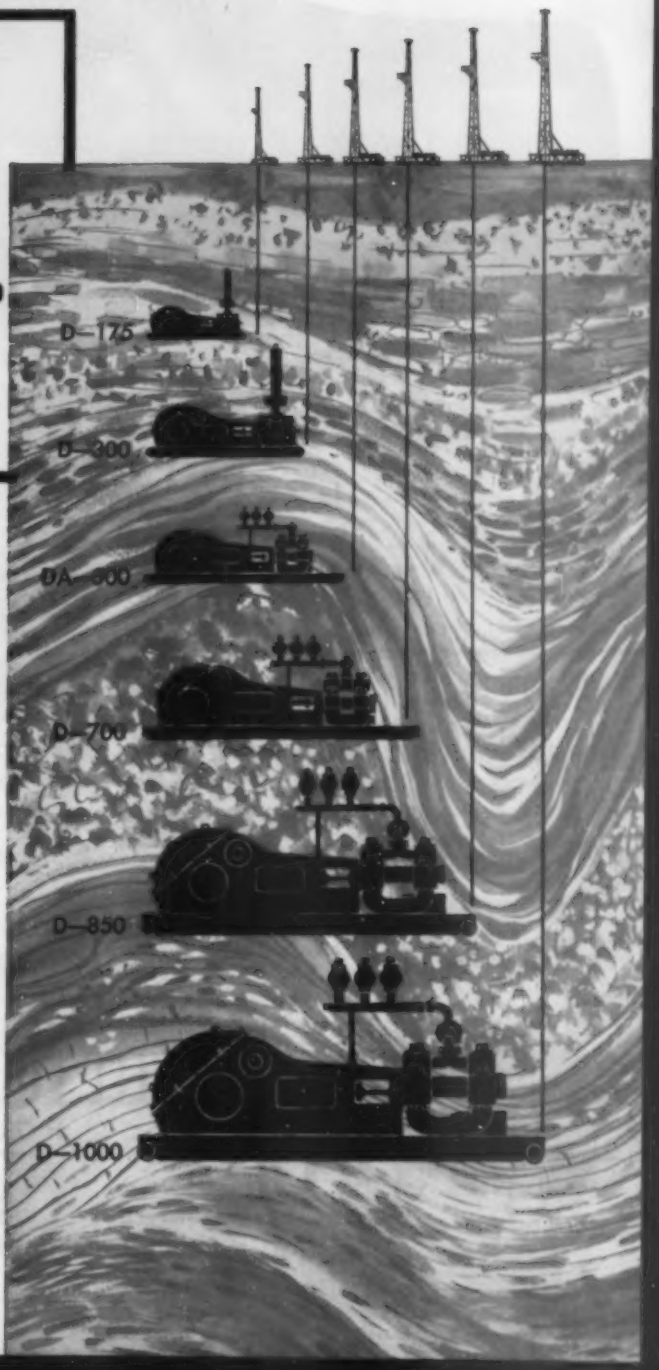
TEXAS AND MILBY ST. • P. O. BOX 3127 HOUSTON 1, TEXAS

Dependable Performance • Advanced Design • Low Cost Operation

EMSCO SLUSH PUMPS

are available in sizes to meet every drilling requirement!





For jet bit, big hole or deep drilling, or for shallow or medium wells, you'll find an EMSCO Slush Pump available to meet your needs. Due to Fabriform construction of the power end, frame is rigid and lightweight, offering easier handling at the rig and less costly transportation. Lubrication is completely automatic. Exclusive patented "exposed" liners enable you to detect and correct liner packing leakage immediately before damage is done. Call your EMSCO representative for bulletins and complete information.

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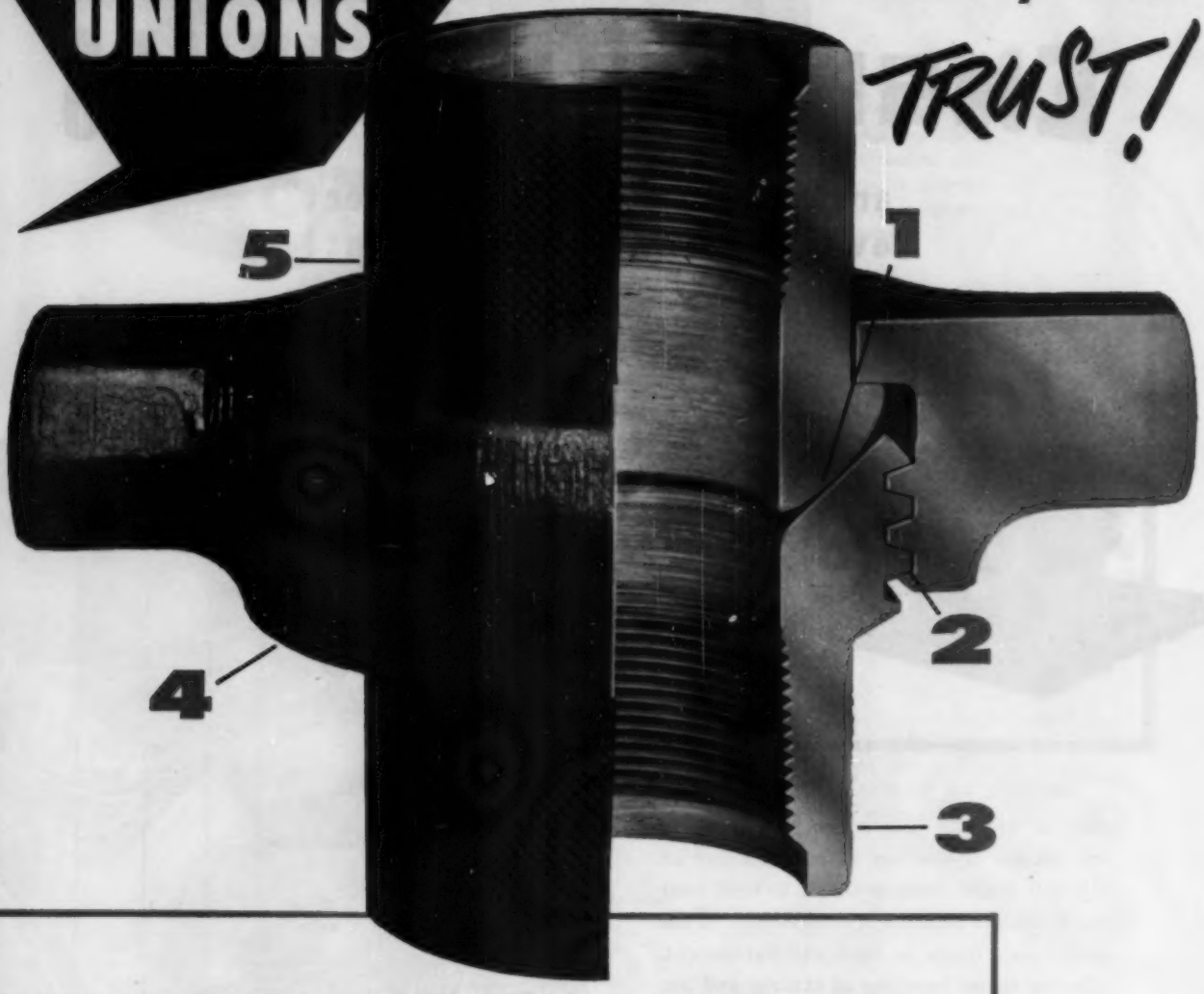
WECO UNIONS

...famous for service you can TRUST!



1. **PRECISION-MACHINED BALL AND CONE SEAT** produces a metal-to-metal seal that holds like a vise against high pressures, shock, surge and vibration.
2. **RUGGED ACME THREADS** on female sub and wing nut make-up and break-out fast — time and time again — without damage or distortion.
3. **HEAVIER WALL SECTIONS** give WECO Unions extra strength, extra ruggedness against distortion, vibration and shock pressures.
4. **STRONGER WING NUT** takes the roughest punishment workmen can dish out — and ask for more — month after month.
5. **SUB ENDS** are machine finished and knurled to assure uniform thickness of wall sections — permit faster, easier wrenching.

WECO®

WELL EQUIPMENT MFG. CORP.

HOUSTON, TEXAS

PESA

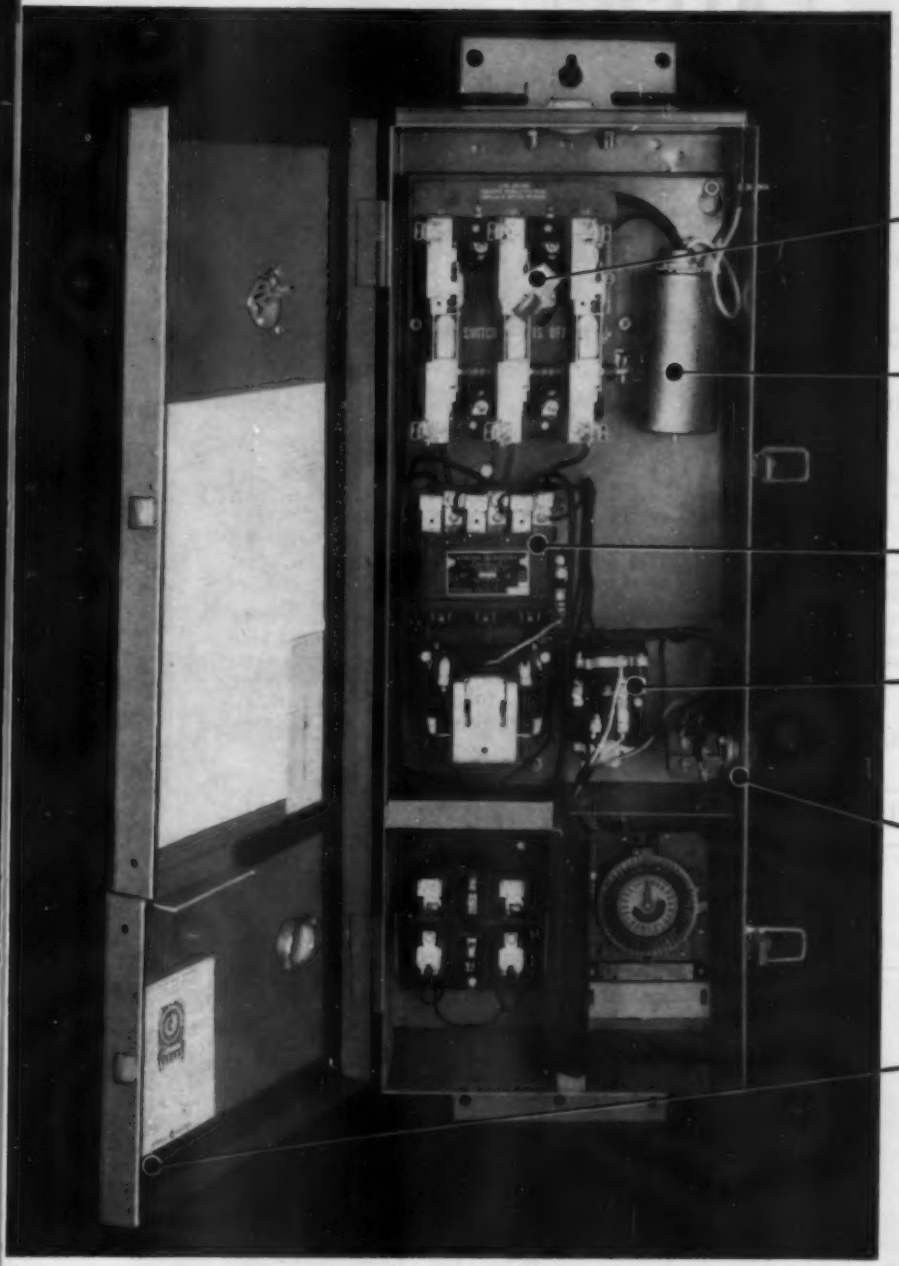
U-9-55

Division of CHIKSAN COMPANY *a subsidiary of* FOOD MACHINERY AND CHEMICAL CORPORATION

fmc
FOOD MACHINERY AND CHEMICAL

IN ADDITION TO THE NEW G-E TIMER . . .

Check these 6 features of G-E oil-well starters that help keep your wells flowing



The new G-E combination timer is one of the many features of G-E oil-well starters that provide dependable pumping of your wells. The timer provides program timing and automatic sequence restart after power failure. Check these other features that help keep your wells flowing:

1. DISCONNECT SWITCH. A high interrupting capacity disconnect switch helps protect the starter against short circuits. Specifically built for this protection, the switch has double-break contacts on individually replaceable poles.

2. LIGHTNING PROTECTION. A 3-phase Thyrite® lightning arrester is connected to the disconnect switch with short leads to maintain arrester effectiveness. Arrester is also connected directly to a grounding stud on enclosure side so that path of a ground is not through case.

3. CONTACTOR. Strongbox coil of contactor is sealed against foreign material and accidental damage. Also, the heavy silver contacts are made for millions of operations.

4. UNDERVOLTAGE RELAY. A high drop-out undervoltage relay better protects motor windings. If line voltage drops to approximately 70%, this relay opens the contactor. Also, the starter will not energize the motor under 'single-phase' conditions.

5. WEATHER-RESISTANT ENCLOSURE. The enclosure finish protects against weather conditions and spreading rust from surface scratches. The narrow shape of G-E starters resists wind, which may cause mounting brackets of wider enclosures to break. Also, with a dust-tight selector switch, dust can't enter the switch and interrupt operation.

6. GASKETED INTERIOR. A neoprene gasket seals the main starter compartment against dust, snow, and rain. Dust can't get in to affect relays, switches or other components.

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FOR MORE INFORMATION:

Section A733-12
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GENERAL ELECTRIC

BLOOMINGTON, ILLINOIS

Horsepower for Horsepower...

ALCO

Standard-Package
DIESEL-ELECTRIC DRILLING PLANT

drills deeper, faster, more economically than any other type of power or transmission

Completely self-contained, the ALCO diesel-electric drilling power package provides 100 per cent standby. No other power is required.

The basic ALCO unit provides 1370 hp for drawworks drive and 600 hp for two mud-pump drives, plus power for lighting and other auxiliaries. A wide variety of standard modifications allow for larger mud-pumps, rotary, mud-mix or coring-reel drives.

Flexibility and simplicity are prime reasons for the diesel-electric plant's economy. The driller has finger-tip control of smooth electric power for all operations, under any drilling condition. And the skid-mounted components can be moved readily from site to site.

This ALCO diesel-electric drilling power package is available at a cost comparable with that of an ordinary power rig. Contact your nearest ALCO representative or write P. O. Box 1065, Schenectady 1, N. Y., for a detailed brochure.

ALCO **ALCO PRODUCTS, INC.**

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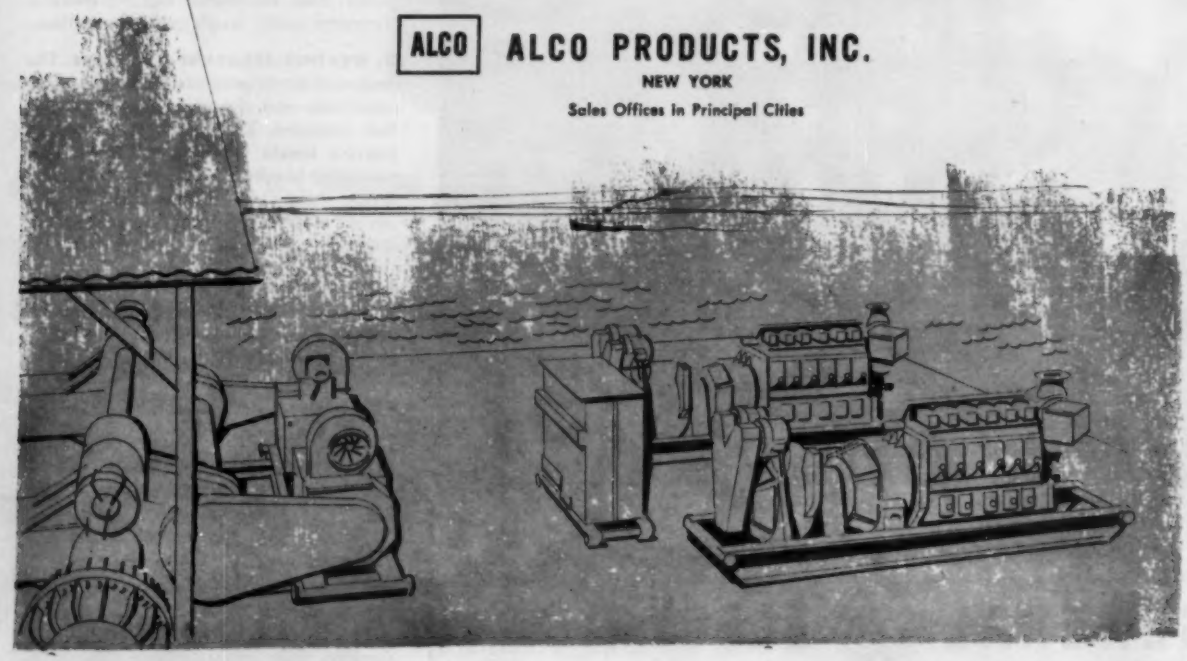
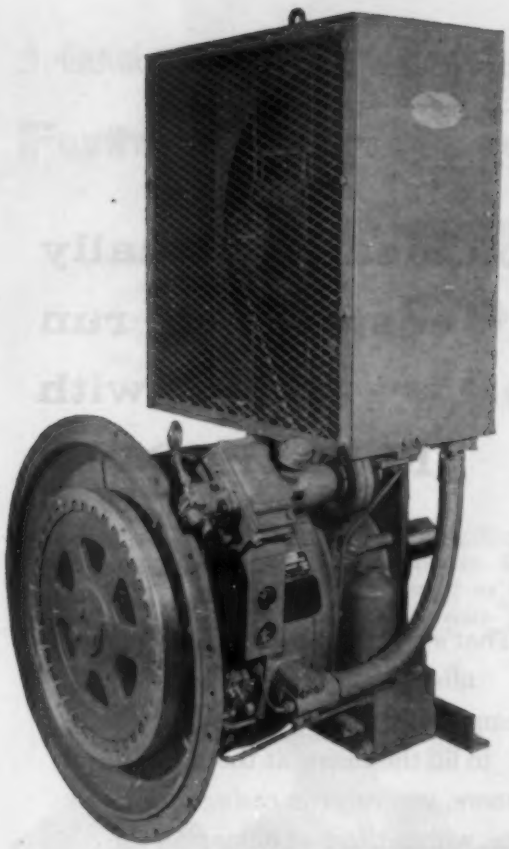
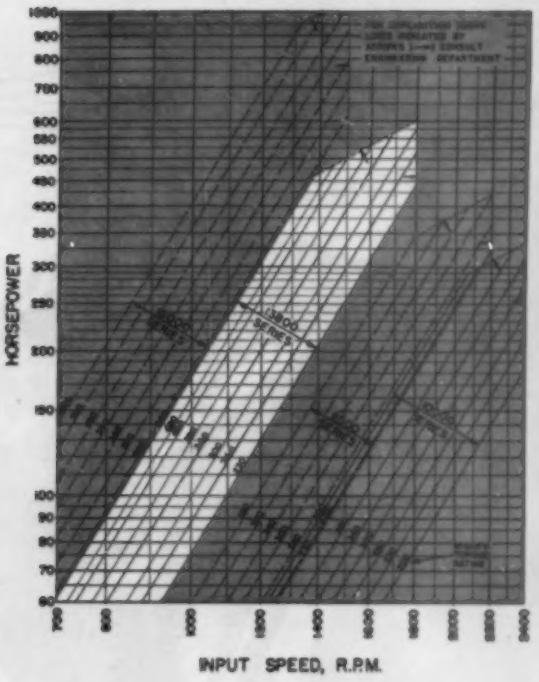






ENGINE APPLICATIONS		
Eng. Mfg.—Model	Eng. Mfg.—Model	Eng. Mfg.—Model
Allis-Chalmers PC1070	Climax V-330	Mercedes-Benz MB836-00
Allis-Chalmers DC1070	Climax V-85	MGO V6S
Allis-Chalmers DSC-1070	Cummins L6R	MGO V12
Allis-Chalmers PCS-1070	Cummins V6SS	Murphy Z4
Allis-Chalmers PC2565	Cummins VT-12	Murphy 122
Cat D-342	Deutz DA8M517	Murphy 222
Cat D-8	Fairbanks 38F5-1/4	Pennsylvania V8FPHR
Cat D-336	Gardner 6-L3	Sterer —
Cat D-8	Hall Scott V-12	Sterling V-06
Cat D-375	Lehwi H-1500	Waukesha 180
Cat D-387	Lehwi H-200	Waukesha 195
Climax V-81	M.A.N. 58W175/122-A	Waukesha 195SC
Climax V-205	M.A.N. 68W-175/122-A	Waukesha L90
	Mercedes-Benz MB836-B	

ANNOUNCING . . . the new Twin Disc 13,800 Series Three-Stage Torque Converter

By W. B. Gibson, Sales Manager
Hydraulic Division, Twin Disc Clutch Company, Rockford, Illinois

With announcement of the new 13,800 Series, the Twin Disc Clutch Company *now* provides a three-stage torque converter for every horsepower range from 40 to 1,000—offering four distinct sizes, with a total of twenty-nine capacities, through internal blading variations.

Designed specifically to accommodate a large number of engines for which previous models were not ideally suited (see listing above)—this new series is planned around a *simple basic unit*—with easy-to-add components which produce ten specific models. This arrangement permits extreme flexibility and speedy interchange of components to provide a model specifically adapted to a wide variety of applications.

The 13,800 Series provides two *output* arrangements. There is *one standard output shaft assembly* designed for maximum side pull loads up to the full capacity of the converter. On this particular output shaft assembly, an output governor take-off is available. There is also *one standard output flange* designed for universal joint or flexible gear coupling drive.

There are also three *input* arrangements—spider drive, incorporating a rubber block drive — which withstands normal misalignment conditions without imposing undue loads or stresses on the input shaft or the engine crankshaft; clutch assembly and independent mounting. In addition to being offered in ten different models, this new torque converter can be adapted, with appropriate engine speeds, to all engines in the 60 to 600 horsepower range by internal blading variations.

Get all the facts on the advantages of torque converter drive in equipment that *you're* planning or designing. Write *now*, to the Hydraulic Division, Rockford, Illinois.

Twin Disc Clutch Company
Racine, Wisconsin
Hydraulic Division, Rockford, Illinois

Heard over a supply store counter...

"You mean it actually costs less to run casing with FLEXIFLOW?"

"That's right... because Flexiflow fills the casing automatically as it is being run, you save the time required to fill the casing at the surface. And what's more, you can run casing at a faster rate, without fear of damaging the formation with high-pressure surges. With Flexiflow, casing running times can be reduced by as much as one-third. That's why it costs much less overall to run casing with Flexiflow."

Flexiflow's Flexible Flow-Control Diaphragm *automatically* adjusts itself to compensate for increases in pressure—automatically relieves harmful pressure surges before they can act on the formation. The higher the pressure from below, the more the hole through the diaphragm expands. And after the first few joints of casing have been run, the hole expands to the point where a joint is filled as each new joint is run. This, of course, is the condition that provides maximum relief from pressure surges (Ram effect). After each joint is run, the hole returns to its original diameter, controlling the fill and preventing overfill of the casing.

Another very important fact about the pressure-relief provided by Flexiflow, is that, in addition to minimizing the danger of breaking down a potential lost circulation zone and setting up a possible bad cement job, the chances are very good that you are at the same time *protecting the producing life of the well.* Pressure surges, created by the use of conventional floating equipment under certain conditions, drive a portion of the well fluid into the formation and tend to "mud-off" the producing zone. This can seriously cut down the production of a well. By using Flexiflow to relieve these pressure surges you are actually protecting the producing formation.

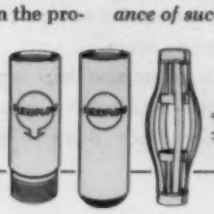
Baker Flexiflow Fill-Up Shoes *(Product No. 160)* and Collars *(Product No. 161)* provide all of these protective features and, in addition, contain the time-tested ball-type back-pressure valve for cementing.

Available now at your supply store, Flexiflow Equipment may be obtained in either conventional form or with the added feature of Baker exclusive Whirler Ports *(Product Nos. 162 and 166)*. Uniform distribution of the cement as it is pumped from the shoe or collar can be as important as having the casing centered in the hole. These whirler ports provide added assurance of getting that uniform distribution, since the cement is forced around and around the casing as it leaves the shoe, minimizing the possibility of channeling.

Baker Fill-Up Equipment, conventional or whirler, used in proper combination with Baker Casing Centralizers and Baker Wall Scratchers, provides you with maximum assurance of successful primary cementing.

Available now at your supply store!

Baker Flexiflow Fill-Up Collars and Shoes
Baker Casing Centralizers
Baker Wall Scratchers



BAKER OIL TOOLS, INC., HOUSTON · LOS ANGELES · NEW YORK

BAKER FLEXIFLOW

A Panel of Experts Discusses . . . .

Future Drilling and Operator-Contractor-Supplier Relations

The drilling contractor stands squarely in the middle of an economic squeeze. Operators want cheaper holes; suppliers must have more profit as the industry heads into its greatest era of activity. With his own profits dwindling, what's ahead for the contractor?

Panel of well-known oilmen representing the operator, the contractor and the supplier discusses some mutual problems in the face of increasing future activity. From left to right, they are: James E. Low, general superintendent of production, Amerada Petroleum Corporation, Tulsa; S. M. Gladney, Southwest Division manager, Sun Oil Company, Dallas; M. G. Rowe, president, Rowan Drilling Company, Fort Worth, who served as moderator; E. Dale Mount, AAODC president and vice president and manager, Harry Bass Drilling Company, Dallas; Fred Mayer, president, The Continental Supply Company, Dallas; and C. J. Davidson, president, Davidson Drilling Company, Fort Worth.

Future Drilling

E. Dale Mount

president, AAODC,
vice president and manager,
Harry Bass Drilling Company,
Dallas, Texas

LAST year, the U. S. oil industry drilled approximately 57,000 wells — for a total of 230,000,000 ft of hole. In 1956, it is estimated, approximately 58,000 wells with 236,000,000 ft of hole will be drilled in the U. S. The demand for oil is increasing by leaps and bounds. Today, the imports plus production in the United States average approximately 8,500,000 bbl per day. By 1960, it will average approximately 10,000,000 bbl of oil.

To keep pace with our domestic production, we must drill a lot of wells. Drilling contractors are the logical people to drill these wells. Considering this demand, it is important to take a look at the trend in the purchase of new rigs in this country.

Rigs Not Keeping Pace

The sale of new rigs is not keeping pace with the operation of the drilling contractors. Something is going to have to give, because obsoletion is rapidly taking place. We are going to have to replace approximately 10 per cent of the rigs that are in operation today. There are about 3500 rigs in the U. S. and Canada today, and about 2900 of them are operating, which is pretty good.

The contractors' Association is keeping members abreast of the times to make them better artisans to do better jobs for customers. We have just about

reached our height of effectiveness with our present equipment, but we are ever alert to look out for new equipment, new ideas, better ways to drill. And we will be persistent in finding these better methods.

The producers, I think, are tired of hearing contractors say they aren't making any money. Usually, when a contractor says that, the producer says "You don't drill fast enough." We have got to be ever alert to keep that from happening.

Job of education. Contractors are not all alike; some can't get the job done as well as others. We are trying through our educational system to make all contractors as nearly equal as we can. We know we are going to have to drill more wells, and find new and better ways to get the job done quicker. We are going to have to compete with other fuels and foreign oil. The commodity market is good; the oil business is good.

More wells to drill. On the other hand, if the general rise keeps coming that we anticipate by 1960, we will probably be drilling between 60,000 and 65,000 wells a year. We don't know where we are going to drill, but we will drill somewhere. Contractors are going to stick together, do a good job, and give the industry a good run for its money on a foot of hole.

Future Drilling

James E. Low
general superintendent,
Amerada Petroleum Corporation
Tulsa, Oklahoma

OIL operators have become accustomed, and have come to expect the contractor to break penetration rate records each year, thus making it possible to maintain the same cost per foot for drilling in spite of continually rising costs of labor and equipment.

During 1955 a plateau was reached. Penetration rates were not increased. I have heard it said in some quarters that the ultimate has been reached with our present equipment. I refuse to subscribe to that belief. I would attribute the plateau to lack of properly trained personnel and obsolescence of equipment in some cases.

Equipment. In looking at present and future drilling, I would like to discuss equipment although I am not at all sure that it should be ranked number one in importance to either the contractor or the operator.

To say that the contractor must keep his equipment up to date if he is to compete; to say that he must have a rig of sufficient horsepower, large volume, high-pressure pumps, torque drives, long drill collar strings, cantilever derricks, automatic drillers, etc.; and to have a rig designed for portability and quick rig-up is academic. You cannot stop here. You must go ahead to better designs and techniques. We may need to think of future rigs as being radically different in design.

Two things that come immediately to mind are light weight, high-tensile strength materials and down-hole powered cutting and percussion tools.

It takes little imagination to visualize large savings in transportation, and rig-up time, if we could reduce the weight of a normal rig from 1,000,000 to 600,000 lb. We would also be able to use smaller hoists and maybe even less horsepower.

The down-hole tools need much more research to perfect them, but they have given promise of greater rates of penetration with possible savings in horsepower.

As to drilling fluids, we need to further develop and improve the technique in the use of gas or air as a drilling medium. The rates of penetration achieved when using these fluids have been fantastic in comparison to conventional methods. Again, it takes little imagination to visualize great savings if we could drill from 5000 to 12,000 ft in West Texas in 12 to 15 days instead of 60 to 70 days.

Personnel. The contractor must attract the best quality young men. To do this he will have to offer more stable employment, wages equivalent to competitors in other industries.

The contractor will have to have supervisors trained in leadership and who are able to instill in their crews loyalty to their company, pride in the drilling industry and a sincere desire to get the job done. These supervisors will have to have the organizational ability to keep the job moving; they will have to be capable of keeping themselves informed on new developments, to help design new equipment, and new techniques. They must be able to cooperate with the operators' personnel. We no longer can run the drilling well as a one-man show. Its complexities demand a team of experts.

Top level cooperation. Cooperation is necessary on a higher level, too. Top management of the contractor and operator must work together. The operator must consider the contractor a part of his organization. In no other way can our common problems be solved efficiently. I would like to remind the operator that one of the best ways to help promote efficiency in the drilling of wells is to furnish the contractor with a continuity of work. If the contractor can move from a completed well to a location previously prepared with no-shut-down time, he is able to retain his crews; he is able to keep them thinking that time is important to both the contractor and operator; he is able to drill a faster hole; he is, in short, able to reduce the price per foot of that hole. If you can sell the operator on this latter idea you might not have to re-bid development wells as often.

Work stability needed. We can't overlook the financial stability that is required of modern day and future drilling, either. The staggering investments in rig and equipment mean that the contractor can no longer work out of his hip pocket. He must have people helping him who are trained in all phases of finance. The unit investment in drilling equipment will, in all likelihood, increase in the future. Those contractors who contemplate making or having made these huge investments have the assurance that our expanding economy has an almost insatiable desire for petroleum products to the extent that within the foreseeable future our consumption will continue to skyrocket.

Cheaper holes needed. All items previously discussed are but tools with which to do the one necessary job: **drill cheaper holes.** This does not mean that your present profits are excessive. It does mean that we must find a faster way to drill a well.

The U. S. oil industry finds itself today at the place our forefathers found themselves a few generations ago when they could no longer pull up stakes and go farther west to find more virgin soil. We have already prospected and are producing the virgin or obvious oil fields. We now find ourselves in the position of having to drill for marginal sands, of having to drill deeper, of drilling on small, less-attractive prospects, of having to supplement our geological and geophysical information with drill holes in our search for stratigraphic oil. All this means we will drill a greater percentage of dry holes in the future, which adds up to a necessity for cheaper holes.

We must, in addition to all our other problems, compete in the marketplace

with foreign oil that is presently produced from the virgin structures. Yes, I repeat, we **must drill cheaper holes.**

Expectations. Operators expect to lean on the contractor quite heavily in the future. To sum it all up, one might say that all we expect of you as a group is that you (1) retain the ruggedness, ingenuity, and drive of the pioneer driller, (2) the research and technical ability of a Kettering, and (3) the business acumen of a Rockefeller.

Cooperative Supplying

Fred Mayer
President,
The Continental Supply Company,
Dallas, Texas

COOPERATION is necessary when you have mutual problems. Many of the problems of the drilling contractor are also the problems of the supply companies.

A certified public accountant examined the accounts of 23 drilling contractors. Four of these companies reported no profit at all. The rest showed a profit of from 1.85 per cent to a top of 3 per cent return on their investment.

Price-Waterhouse gathered the statistics on the supply industry. In 1952, the profit made by the supply companies was 2.59 per cent of total dollar sales. Every year since, this figure has been reduced. In 1954, well under 2 per cent of our sales went into net profit. In 1955, I am sure this figure was substantially reduced. This is a compelling basis for cooperation.

Suppliers job. In this cooperation, the supply group's job is to provide the contractor with continually improved equipment. With the competitive situation that arises, it will be necessary to drill wells cheaper. It is up to us to endeavor to find some solution. The industry has not been asleep.

There is much talk nowadays about down-the-hole rotary drilling. We have not been asleep in this country. Millions have been spent to find the answer to down-hole-powered rotary equipment. One company has spent millions on research on sonic drilling.

Another job of the supply group is to have equipment and supplies of good and modern design near you, where you need it and when you need it, and at a price returning a fair profit to the supply industry.

Delivery service abuse. It seems to me your cooperation in buying is to insist on such service from the supply companies. But it also seems to me that you should not demand extra and unnecessary services, since the cost of such services is eventually going to find its way back into the cost of the product. There have been some bad practices, which probably have been initiated by the supply companies. One of them is field delivery. There is now a move away from these abuses, and some AAODC members are taking the lead.

Formerly, the supply industry did not have supply trucks; that cost the industry millions of dollars. Delivery is costing all of us money, and daily rig calls cost a tremendous amount of money. Many orders could be placed by telephone instead of waiting for the supply man to come to the rig.

Trade-in problem. Another vital problem is the question of trade-ins. There is room for legitimate trade-in of equipment that has reasonable economic life. There is also a case for excess equipment such as when a rig is being cannibalized or heavied up. But when you have a piece of junk equipment and call in several supply companies to bid on it, there is something wrong. When this junk equipment shows up later on a drilling job, it vitally affects the drilling contractor.

Very often the profit of the supply company on new equipment is tied up in a piece of equipment that has very little economic life. The supply company can't throw it away. It lies in their inventory, then sold to someone and it goes into the hands of some hardly-able individual. Some producers are not careful about checking equipment to be used on their wells. The contractor with poor equipment doesn't figure on depreciation, etc., and cuts the price. He may be a good man and can build himself into a good contractor. But in many of these cases, all that happens is the price is cut to the drilling company.

I don't know the answer, but we feel that if a contractor uses equipment for its full economic life, then scraps it, both industries would be better off.

Economic relations. Suppliers desire to encourage to the greatest degree all of the cooperation possible with the drilling contractor industry. The supply industry appreciates that it is tied to the contractor for its profits. The influences and the effects that adversely affect the supplier's economic well being must fundamentally adversely affect the prosperity of the supply group.

Cooperation and Dependability

S. M. Gladney
Southwest Division Manager,
Sun Oil Company, Dallas, Texas

SPECIALIZATION has been one of the major developments in industry. This is true of the oil industry also. I am told that 92 per cent of the approximately 57,000 wells drilled in the U. S. in 1955 were drilled by contractors.

The Southwest division of Sun Oil Company no longer owns a drilling rig. The result therefore is that to all intents and purposes, the contractor is the drilling arm of the oil industry.

Along with the trend toward specialization, we realize the increasing need for complete understanding and wholehearted cooperation. A lack of such understanding and cooperation would completely nullify the benefits of specialization.

Bid price not all. Price is not the only consideration when we let a contract, or even the first consideration. Naturally, we want a good deal and fair prices. We don't want to pay more than necessary for the job. We make it plain that our contract does not always go to the lowest bidder. In our company, the well is sometimes half-way down before we sign the contract.

The reputable contractor is known not only for his efficiency, but as a man of his word and fair in business dealings. We want someone upon whom we can depend to do the job. We expect him to have first class equipment, and we expect to pay him enough money to keep him in business. Keeping good contractors in operation is good business.

Adjustments offered. Our policy is to adjust the account so the contractor will not lose money. We like to work

closely enough with the contractor so that he can bring in his records and show us if he feels there should be an adjustment. The records have convinced us on occasion that an adjustment is in order. On the other hand, if the situation is reversed, we think the contractor should be willing to make adjustments on the hole.

We have had very good relations with drilling contractors. So far as I know, we have never sued a contractor nor have we been sued by one. This close contact and cooperation between operator and contractor helps to keep disagreements down by settling them before they get too big.

Records kept. Where we have several contractor rigs in one area, we keep charts and logs on all wells. We make a log on every well drilled, and chart the time it takes to drill certain formations. In this way, after three or four wells are drilled, if the contractor comes in and tells us he is not making any money, all we have to do is show him the chart on what he has done and what his competitor has done. Very often this results in a change in his personnel. It has saved us a lot of money and saved the contractors a lot of money.

We also expect certain things of our contractors. We expect them to keep in close touch with the drilling job. And we certainly want a contractor who will not get in competition with us in buying leases or minerals.

Gift abuses. We especially want to point out a growing tendency which should be curbed. This thing of showering gifts on employees at Christmas is getting out of hand and leads to abuses. In practice, it often backfires.

Gigantic task ahead. The idea of cooperation is not new. Together, you and I and the companies we represent have a gigantic task before us. The search for new methods grows wider and wider; drilling grows deeper and deeper, and at much greater expense. The oil industry has never let the country down. By improving methods and by applying know-how, the contractor has proved his worth. He must develop even better equipment and improve his methods even more. The price problem will work itself out if he will continue to do that. With close cooperation between drilling contractors and producers, we can continue to meet the task ahead.

Company–Contractor Suggestions

C. J. Davidson
President,
Davidson Drilling Company,
Ft. Worth, Texas

COMPANY-contractor relationships, and/or suggestions is a topic with latitude and not very much longitude. First, my relationship with all the oil companies since I have been in the business has been very good. As to the suggestions I might offer, all of the oil companies are getting deeper wells at better prices.

Fluctuating economics. Conditions as they exist are quite acute from the contractor's standpoint and changes must come about. You must allow the contractor more liberal fees if services are to be commensurate. Some methods must be originated so prices can be scaled up or down, according to national and industry economic trends. This is more of a job for the contractor to search out, since he is the one rendering the service. But both sides should recognize the trends and give early relief, each to the other, when it is demanded and justified.

Better hole specifications. The company should make available every specification and every detailed procedure in order for the contractor to make an intelligent bid. If changes are made by orders of the company after drilling begins, then the contractor should be remunerated for it. Sometimes there is a change in the size of the hole to be bored, or the type of equipment to be used. Radical changes in the drilling fluid are most important and very annoying. When there is a departure from an agreement, the contractor should be remunerated. Often times, the company requires special or unusual equipment. You might have it, but the company should be willing to accept what you have to offer. The contractor can't often afford to add special new items, and he should be paid for them when they are required.

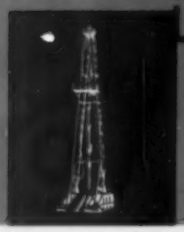
Contractor's move. Don't forget, we are making a valiant fight to keep free enterprise in operation. We all must have a definite philosophy in doing business and it is never a one-way street. Most producing companies know that contractors are positively not being adequately paid for their services. What should be done to cure the problem? Should the companies suddenly launch a missionary movement? It is the contractor's move, and the contractor is mostly to blame. He should bid realistically to meet present conditions. He imperils his own position. But the contractors can't perform without proper financial nutrition.

There is no desire on the part of the producing company to destroy the drilling segment of the industry. Producers know they are a standing army with equipment and personnel and know-how, ready and willing to do battle. Furthermore, no organization in the oil patch gives any better service than the well digger. They are helping to cure other problems in the business, too.

Number one pain. More wells are drilled each year, and they are going deeper, requiring better equipment. In spite of this, prices are on the decrease. Drilling prices are the contractors' number one pain at the moment. I urge that we work to the end, and maintain the excellent relationship we have enjoyed so many years.

Editor's Note: A symposium-type meeting of the Dallas-Fort Worth Chapter of the AAODC was held March 27, 1956, in Dallas. Its theme was: "Future Drilling and Company-Contractor-Supplier Relations." The panel consisted of five noted oilmen: E. Dale Mount, AAODC president and manager and vice president, Harry Bass Drilling Company, Dallas; James E. Low, general superintendent of production, Amerada Petroleum Corporation, Tulsa; Fred Mayer, president, The Continental Supply Company, Dallas; S. M. Gladney, Southwest Division manager, Sun Oil Company, Dallas; and C. J. Davidson, president, Davidson Drilling Company, Inc., Fort Worth. M. G. Rowe, president, Rowan Drilling Company, Fort Worth, served as moderator. Purpose of the symposium was to bring about a better understanding and appreciation of the immediate and future problems of the three segments (operator, contractor, supplier). The following discussions have been abstracted from the five talks given to present the essential points brought out.

LANE-WELLS today!



published for the busy oil man by Lane-Wells Co.— one of the Dresser Industries

Plugging Problem Studied

New perforating techniques to avoid trouble may result from extensive tests conducted by Humble's researchers

FORT WORTH. – New ideas on how to make jet and bullet perforating more successful have been turned up by Humble Oil & Refining Co.

The ideas resulted from a comprehensive study just completed by Humble in cooperation with perforating-firms. The results were reported at the A.P.I. Production Division's southwestern district meeting here by T. O. Allen and H. C. Worzel of Humble's Houston offices.

Tests, according to the Humble men, revealed there are important factors to consider other than depth and area of shot hole. They took into account pressure differences between formation and well bore and type of fluid in the bore as well as design of gun and charge.

Plugging . . . Most significant finding appears to be that considerable plugging of perforations results from use of both jet and bullet guns.

Also this plugging can be reduced by using the right gun and proper perforating techniques. Plugging was found in some instances to stem from gun or charge design and in others from downhole condition during the operation.

Generally, Humble found these two rules to hold true:

. . . Don't perforate with drilling mud in the hole. The perforations often are plugged with mud, sand, and charge debris. Use of a clean fluid such as oil or salt water where possible helps prevent this.

. . . Don't perforate with differential pressure from the well bore into the formation. This helps carry mud, charge debris, and sand into the perforation. Back-flowing often cannot clean out the plug.

The company also found that many jet perforators plug the perforation with "carrots" or plugs which are part of the charge liner. They are carried into the shot hole by the jet stream.

Wedge-shaped liners do not appear to produce carrots that survive the detonation but cone-shaped linings with apex angles of 60° or less do.

Humble thinks that this fault of cone-charge design can be corrected if the liner is asymmetric. Then the carrot and the jet stream travel in slightly different directions.

Those charges exposed to well fluid apparently do not produce carrot plugging since detonation pressure is expended in all directions. Those charges in aluminum or closed-steel carriers proved to be the worst offenders.

When differential pressure is from formation to well bore, considerably fewer carrots are found in perforations. Other Humble findings:

. . . Both jet and bullet guns cause compaction of sand around a perforation. If this is held in place by mud, sand, or charge debris, it causes a reduction in well productivity.

. . . Penetration with bullet guns drops as the strength of the casing and formation rock increases.

. . . Better cleanout and flow rate result with smooth perforations 7/16 to 1/2-in. in diameter and 6 or 7 in. deep rather than with much deeper but rougher holes with smaller diameter.

Wrong sign . . . Perforation plugging is a serious problem because it can cause erroneous small estimates of productivity in wildcat wells or new zones in field wells.

Plugging can also cause:

. . . Premature flooding of completion intervals with salt water or gas, thus forcing abandonment of recoverable reserves.

. . . Aggravated sanding problems, in unconsolidated sands, by causing excessive pressure drawdown around perforations remaining open.

. . . Irregular drainage of various members of laminar sands like those producing oil on the Gulf Coast.

Check G-1 on the attached card for the full story.

Reprinted from Oil and Gas Journal, April 2, 1956

NEW #7 POWDER CHARGE EXTENDS BULLET REACH

Betters Payoff Chance

In an oil zone, the difference between success and failure may ride on the head of a perforator bullet. An inch of penetration, more or less, may spell the difference between commercial production and abandonment. Thus the development of the new Lane-Wells #7 powder comes as mighty important news to oil men. This because the 24% greater penetrability of this new propellant means an even

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greater proportionate chance of job success.

In the first place, the resulting deeper penetration gives correspondingly greater drainage area. Twenty-five 15/32" shots fired through casing and cement into a hard formation by the Lane-Wells #3 powder (still rated a powerful propellant, by the way) might result in a total drainage area of about 110 square inches.

The same number of bullets fired from the same guns using #7 powder would yield a total drainage area of 140 square inches. The thirty extra square inches alone will mean more barrels of oil per day, quicker payoff, and more return on the original investment.

But that is not all. As production men know, filtrate from drilling mud will substantially reduce the oil permeability of any zone that it penetrates. This water blocking effect decreases radially from the well shaft. Thus, bullets given 24 per cent greater penetration because of the #7 powder may help to realize much greater than 25 per cent increase in production, because they will have reached a zone of increased oil permeability. Just how Lane-Wells engineers were able to design a powder which would give greater propelling force without decreasing safety factors, makes quite a story in itself. Told simply, and in exquisitely nontechnical language, the #7 powder doesn't just go off with a bang, with a short high peak of maximum explosive effort. It gives a sort of prolonged push. In terms of the refining gentry, it would have a high-octane, high anti-knock rating.

If you check G-2 on the attached card, Lane-Wells will be happy to send you more information about this remarkable powder.

LANE-WELLS OFFERS TWO KONESHOT GUNS FOR THRU-TUBING WORK

Once an interesting possibility, thru-tubing perforating now has advanced to the stage where operators can exercise considerable choice about the equipment employed. The question no longer is: Can the job be done? Now it is: Which equipment can do the job best?

Lane-Wells offers two different types of small-diameter Koneshot perforators for thru-tubing operations. Each one, though slimmed down in bulk to permit easy passage through lubricator and tubing, will do a man's size job of perforating. Each gun is adjustable for length, and one has adjustable shot spacing. While the perforators themselves have been scaled down, the safety operational program is king size; in other words, it's the standard Lane-Wells five-point safety system.

Here are the specs on the Lane-Wells thru-tubing guns. One will do the job best for you.

The J-1 Retrievable Perforator —This gun leaves *nothing in the well to interfere* with production or operational procedure. Available in 1¾" and 2⅛" O.D. sizes. Both use 180° phasing in 4-foot shooting sections. Fires six shots per foot in 1¾" O.D.; four shots per foot in 2⅛" O.D. Fires all shots horizontally. Operates in pressures up to 20,000 psi.

The Swing-Jet Gun – This perforator is available in running-in O.D. sizes of 1⅜" and 1¾", which swing out to a shooting O.D. of 3⅛" and 4⅜" O.D., respectively. The Swing-Jet principle permits great power and deep penetration within the restrictions of thru-tubing operations. Carrier is frangible thin-walled aluminum. Charges cannot be fired in any but the shooting position. Adjustable for length, guns fire four charges per foot at 180° phasing.

Check G-3 on the attached card for all information on these Junior-sized instruments for King-sized performance.

SUPER BRAINBREAKER

Two brothers and two sisters inherited 1000 acres of land in the form of a parallelogram. By the terms of the will each of the two sisters inherited 35% of the total acreage and each of the brothers 15%. Also, under the terms of the will, each allotment had to border on the outer perimeter of the 1000-acre plot and each had to have a common point on the long diagonal of the parallelogram.

Geometrically demonstrate and prove how this apportionment could be made.

Check G-4 on the enclosed card to determine the right answer.

Answer to folded paper problem in last issue: The length of the fold CD is 9.23".

ABSTRACTS — CURRENT AND PERTINENT

GET THAT GRADUATE, AND HOW – The rush is on for graduating engineering personnel. Interviewers and placement personnel speak out on how oil companies and colleges can work together to expedite employment. Check G-5

THROUGH TUBING RECOMPLETION PAYS OFF, OFFSHORE – Transporting and lifting a derrick to recomplete an offshore well would cost big money; so, the operators decided to rework the well through tubing. They succeeded – and at a saving of 84%! Check G-6

A FISH STORY, WITH A MORAL – The moral in this case is that persistence, though expensive, proved cheaper than redrilling from a new location. Check G-7

HITTING A ONE-FOOT TARGET AT FOUR MILES – STRAIGHT DOWN – Finding and perforating the desired interval at 21,670' called for highest order performance on the part of the wireline equipment involved. Temperatures and pressures ran better than 340° F. and 20,000 psi, respectively. Check G-8

PERFORATOR SELECTION MADE EASY – What to expect in the way of jet or bullet perforating is graphically shown. Chart enables operator to choose type of instrument best suited for his job. Check G-9

ANYBODY FOR THE GOOD OLD DAYS?

The snappy rig pictured above delivered nitro to the oil fields about the turn of the century. Safety precautions called for the umbrella to prevent sunstroke. So well did this work that practically none of these blitz wagon drivers ever died of sunstroke.

THRU-TUBING INSTRUMENTS YIELD FULL-SIZED LOGS

If an operator wants to log his well through tubing, he can get just as good a log as one run through casing—with Lane-Wells on the job. For, in Radioactivity logging of permanent type completions, only the instruments have been scaled down; accuracy, sensitivity, and formation delineation remain the same.

In every test, the junior-miss-sized logging instruments have yielded results on a par with those coming from their heftier counterparts. Headaches connected with getting the job done by means of a small diameter instrument, have been ironed out by Lane-Wells engineers—who, no doubt, had a few of their own in the process.

Designed especially for thru-tubing operations, the Series 300 Radioactivity Well Logging equipment utilizes the latest developments in Geiger-Mueller radiation detectors. The downhole Gamma Ray-Neutron instruments themselves are available in 1¾" and 2⅝" O.D. sizes. With both, as with the standard-sized instruments, Lane-Wells offers simultaneously run collar logs. An even smaller 1⅜" Gamma Ray instrument also is offered in certain areas.

To supplement the instruments running in the hole, Lane-Wells utilizes surface control equipment designed and built especially for permanent-type completions. In fact, Lane-Wells is the only company that supplies a completely integrated thru-tubing operation. One phone call will bring a completely operational unit.

Check G-10 on the enclosed card to find out more about it.

NEW DOMESTIC SALES MANAGER

C. L. Kirkman has been named Manager of Domestic Sales for Lane-Wells Company, one of the Dresser Industries. In making the announcement, Jas. D. Hughes, Vice President for Sales and Service, pointed out that Kirkman will have charge of the company's sales activities in the United States.

Kirkman has been Division Sales Manager for Lane-Wells Mid-Continent Division with headquarters in Oklahoma City. A graduate of the University of Oklahoma, he joined Lane-Wells Company in 1937. He has held most of the positions in both operations and sales in the division.

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LIFTING LUGS which insure release of the sealing element.

LARGE BY-PASS (in valve-type packers) which gives fast running in fluid.

FULL-DIAMETER mandrel which allows free passage of tools.

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Corrosion in Gas Lift Wells Reduced by...

Squeezing Inhibitor Into Formation

Treating costs cut 49.9%; treating efficiency increased 16.9% by new idea in corrosion mitigation

Rupert H. Poetker*
John D. Stone**
Sunray Mid-Continent Oil Company

A new method of treating corrosion in gas-lift wells by squeezing inhibitors back into the formation resulted in increasing the treating efficiency by 16.9 per cent and lowering treating costs by 49.9 per cent. This test was made on 11 wells in one field, case histories of five such wells are presented.

Corrosion control of gas-lift wells has become a difficult problem. Usually the corrosion that occurs in these wells is of the water-dependent type; i.e., the wells produce for a number of years without corrosion but when the water production increases sufficiently, corrosion becomes severe. Corrosion control of gas-lift wells is difficult for the following reasons: 1. Limitation of treating methods; 2. inability to control chemical-injection location; and 3. inability to economically measure corrosiveness of fluid or to measure the amount of corrosion occurring in the well.

The Placedo field of Victoria County, Texas, was developed in 1936 and 1937 and was produced with no corrosion damage to well equipment for 12 years. Most of the wells in this field are completed in the Greta sand or in a stringer sand slightly above the Greta at a depth of approximately 4700 ft. The Greta sand is a very loose unconsolidated sand with a permeability of 3000 to 5000 millidarcys, and a porosity of 32 to 34 per cent. Tubing failures resulting from corrosion were first noticed in 1948; and by 1951 the corrosion had become a severe problem. Several expensive fishing jobs were required and tubing and valve failures became quite numerous. In 1951 there were around 20 tubing failures caused by corrosion in a field where only 80 wells were operated. The average cost of pulling these wells and replacing the corroded tubing averaged a little over $4000 per job, giving a total corrosion cost for 1951 of $80,000. Needless to say, corrosion costs in this field were excessive.

In late 1951 a program was started to determine how much corrosion was occurring and which wells were being corroded most severely. Corrosion test coupons were installed in the high water-producing wells, caliper surveys were run, and iron content of the produced water was determined. The caliper surveys showed that the tubing in each of the wells with a high water-producing rate was in very poor condition. The results from the surface coupons were very inconclusive; in fact, most of the coupons gave a corrosion rate of 2 to 4 mils per year regardless of the well's productivity. The iron content of the produced water was very erratic but did correspond somewhat to the history of the well's corrosiveness. Treatment was started in some of the wells based on caliper-survey data and well histories, but not on coupon corrosion rates or iron content of produced water. It was hoped that treatment, along with coupon and iron-content studies, would give results which could be used to help interpret previous results.

Batch treatment. Chemical treatment was started in a few of these wells in early 1951. However, an organized program was not started until late 1951. The most corrosive wells were those which produced large quantities of water, from 800 to 1500 bbl per day. Treatment with stick chemicals was not feasible inasmuch as it would require a shut-in period of 3 to 4 hrs. A shut-in period of this duration would interrupt the well's production and would take 1 or 2 days before the well resumed normal production again. Use of a macaroni string inside the tubing was discarded because it would greatly decrease the efficiency of the gas-lift operation unless larger tubing could be used, and the larger tubing was not available. The treating method used was that of daily batch feeding chemical mixed with 5 or 10 gals of well fluid into the annulus.

Results of batch treatment. Because these wells made large amounts of water and considerable amounts of sand at relatively high velocities, erosion of coupons by sand was so much greater than the corrosion rate that little difference in coupon corrosion rate was noticed before and after treatment. Iron content of the produced water, although still very erratic, indicated that some protection was being achieved. These iron counts indicated that a treating efficiency of some 30 to 50 per cent was being accomplished. Because the iron counts indicated that treatment was somewhat effective and since no other method presented itself, this batch treatment program was continued and expanded to other wells. In April, 1954, a severe tubing failure was encountered in a well that had been treated since April, 1951.

Prior to chemical treatment, Well 1-B produced between 800 and 1000 bbl of brine per day and had experienced 3 tubing failures due to corrosion. These failures occurred in April, 1948, February, 1949, and April, 1951. After the first failure a new string of tubing was put in the well and this new string failed in 10 months. In April, 1951, just after a tubing failure, treatment was started in the well. The well was first treated with an inorganic inhibitor for about 6 months and the chemical was then changed to an organic inhibitor. The well was treated with 1 gal of chemical and 5 to 10 gal of well fluid daily for 3 years. This well produced normally and gave no indication of a tubing failure. However, the well sanded up and a workover was required. The tubing was pulled and was found to be parted at approximately 1800 ft, just below the upper gas-lift valve. The tubing was then fished and

*Corpus Christi, Texas.
**Benton, Louisiana.

10 or 15 of the joints that were recovered did not have an upset on either end. The tubing had not been normalized and severe ringworm corrosion had occurred. Corrosion had been so general throughout these joints that a joint could be lifted easily with one hand. The tubing above the upper gas-lift valve was in fair condition. It was apparent that chemical treatment had not gone below the upper gas-lift valve.

Fig. 1 shows the iron content of the produced water, the pounds of iron produced per day by iron content, and the pounds of iron produced per day by the formation water. This shows the iron content to average 31.4 ppm, 39.8 ppm, and 34.4 ppm for 1951, 1952, and 1953, respectively. The average net pounds of iron produced per day for 1951, 1952, and 1953 was 12.4 lb, 16.6 lb, and 14.6 lb. Several other wells gave similar results; however, the failures were not as severe.

Also, in early 1954 another disadvantage to the batch treatment was discovered. A tubing failure occurred in one well at about the 3000-ft depth; and when the tubing was pulled, a coating of chemical from ¼-in. to ½-in. thick was found on the outside of the tubing. It is believed that this was the result of insufficient diluent with the chemical. This was probably brought about by the dehydration of the chemical by the gas. The chemical was diluted with only 5 or 10 gal of water and batched into the annulus. This was just enough fluid to wet the outside of the tubing and inside of the casing; and as the dry gas was injected over a 24-hr period, the chemical was dehydrated and remained on the tubing as a gummy coating. To verify this theory, the chemical was batched into the annulus and then followed with 2 bbl of well fluid. This was done only on a few wells and results are shown in Fig. 2. The increased amount of wash water improved the treatment but not enough to justify the added expense.

Inhibitor squeeze. Because the batch treatment method was not as successful as was desired, a search for a new and better method of treatment was made. The idea of squeezing the inhibitor back into the formation seemed to be worth investigating. Preliminary laboratory tests were run on sand samples obtained from the Greta formation to determine: 1. Whether or not the inhibitor would be adsorbed onto the sand particles; and, 2. if the chemical was adsorbed on the sand, at what rate it would be desorbed from the sand by the flow of brine. These tests were run at atmospheric conditions and no definite conclusions could be reached as to what would happen to the chemical in the formation. However, the results did indicate that it would be possible to "squeeze" inhibitor into the formation with no adverse effects and that inhibitors with the proper characteristics would adsorb to the sand and would desorb slowly enough to give a period of protection when the well was producing.

Procedure. A small triplex pump, rated at 5 gpm, and a small centrifugal pump, rated at 40 gpm, were used to pump the chemical into the wells. Annulus of the first 2 wells squeezed was loaded with brine prior to squeezing. However, this has been discontinued and no adverse effects have been noticed. The chemical (usually 55 gal) was pumped into the tubing and followed with 2 qts of de-emulsifying chemical in 15 bbl of brine or oil. This was then followed by sufficient brine or oil to displace the liquid in the tubing and force the chemical back into the formation a desired distance. The proper distance to force the chemical back into the formation will vary depending upon the sand and chemical.

Results of inhibitor squeezes. Eleven wells in the Greta formation have received one or more squeeze treatments. Production from two of the wells was changed; however, it is believed that neither was completely due to the inhibitor squeeze. One well went to 100 per cent salt-water production after a squeeze. This is not an unusual thing in the field; several other wells have done the same thing, and they had received no treatment whatsoever. Therefore, it is believed that this inhibitor squeeze did not cause the change in this well's production.

The other well had a change in production from 8 bbl of oil and 85 bbl of brine before treatment to 92 bbl of oil and 550 bbl of brine per day after treatment. This was probably caused either by a slight fracturing of the formation or a cleaning of the sand by the detergent effect of the chemical. Two

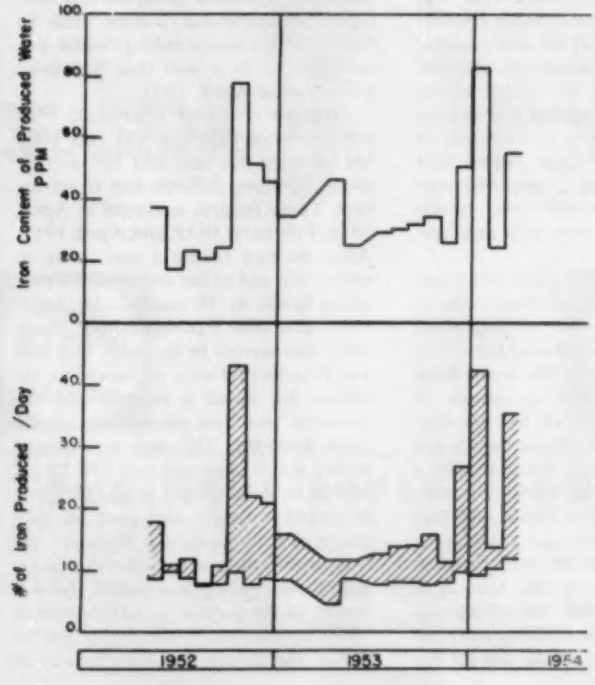
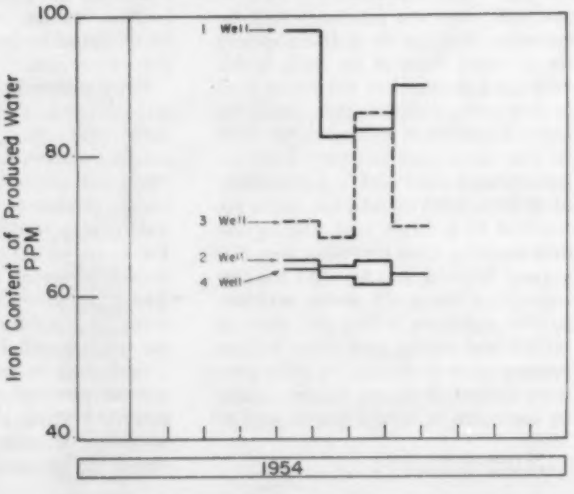


FIG. 1. **Iron content and iron produced** in Well 1-B. Other wells gave similar results but tubing failures were not as severe.

FIG. 2. **Effect of increased wash fluid** to overcome deposition of hydrated chemical inhibitor as gummy coating on outside of tubing.



wells in the 5500-ft sand have been squeezed with inhibitor, and one of these wells was affected by the squeeze. For 3 days after the squeeze the well made only a very small amount of brine and no oil. However, in about 5 days the well returned to its normal production. The formation in this well is considerably tighter than the Greta formation and the bottom-hole pressure is quite low. Apparently a slight emulsion or water block was formed in the formation which prevented normal production until the emulsion broke or until the water forming the block was produced. From this experience it has been decided that great care should be taken if or when a well with a low bottom-hole pressure and a fairly tight formation is to be squeezed with inhibitor. The other well in this 5500-ft sand has been squeezed using both oil and brine as a wash fluid behind the chemical without causing any change in the well's production.

Chemical losses. Some chemical is lost when the well is placed back on production and the amount will depend upon the type of chemical used, the adsorptive power of the chemical onto the sand, and the distance the chemical is forced into the formation. After the load water has been produced, the chemical content of produced water will run between 100 and 200 ppm for a period of time, anywhere from 30 min to 2 hr, and then will go down to around 40 ppm. It has been calculated that anywhere from 1 to 10 gal of chemical would be lost, depending upon the factors mentioned previously.

Another apparent loss of chemical occurs during the first squeeze. It is believed that some of the chemical that is adsorbed to the sand is never released into the fluid. Facts that indicate this is true are: 1. Large decrease in length of time of inhibition received when ½ drum or less of chemical is used; and 2. the second squeeze gives a longer inhibition life than the first. Two wells were squeezed using only 27 gal of chemical and the results of these wells showed that protection was received for only a few weeks, whereas treatment using 55 gal of chemical would last 3 months. In almost all instances the second squeeze was more effective and had a longer life than the first.

When one of these wells produces a large quantity of sand, as they quite frequently do, it is believed that considerable amount of chemical is lost with this sand. Three wells that made large amounts of sand after squeezing did not give as good results as did those that made only small amounts of sand.

Batch versus squeeze treatment. A comparison of batch treatment and squeeze treatment is shown in Table 1. Failures per year were calculated as follows: 1. The failures without treatment were calculated as the average over a 2-year period just prior to and/or just after batch treatment; 2. the failure rate during batch treatment was calculated as the average during batch treatment. The length of time wells were batch-treated varies from 3 years to 8 months; and 3. the failure rate during squeeze treatment is the average as calculated from the beginning of the treatment to December 31, 1955, and varies from 3 to 14 months.

The net pounds of iron produced per day is the difference between the iron production, as calculated from iron content of the produced fluid, and the formation iron content. This net iron production takes into account the amount of fluid produced by the well. The iron content of the formation water has been derived from iron analysis of water produced from wells that have never had a tubing failure.

The treating efficiency was calculated from the reduction in net iron production.

Seven wells treated by batch treatment had an average treating efficiency of 64.7 per cent. These same wells had an average treating efficiency by squeeze treatment of 81.6 per cent, or an increase of 16.9 per cent.

The treating cost for batch treatment averages 86.9 mills per barrel of oil produced and 3.69 mills per barrel of fluid produced. With squeeze treatment, the average treating cost for these same wells is 70.3 mills per barrel of oil produced and 1.85 mills per barrel of fluid produced. This shows a treating cost reduction of 16.6 mills per barrel of oil or 1.84 mills per barrel of fluid by the squeeze method.

The lack of correlation between net

TABLE 1. Comparison of various chemical treatments on Corrosive Wells.

WITHOUT TREATMENT

Well	Tubing failures per year	Iron content of produced water–PPM	Net iron production in lb/day	MPY
No. 1-S	2.0	38.0	3.76	8.55
No. 2-S	—	103.0	2.7	—
No. 3-S	2.0	50.4	4.5	4.21
No. 4-S	4.0	96.6	8.8	—
No. 5-S	0.96	100.6	10.1	4.00
No. 6-S	0.67	30.0	5.5	3.23
No. 7-S	1.0	46.7	16.0	8.26
No. 8-S	1.7	47.8	11.2	1.96
No. 9-S	2.0	41.1	8.8	2.94
No. 10-S	1.25	57.1	4.7	—
No. 11-S	1.5	101.8	3.3	—

BATCH TREATMENT

Well	Tubing failures per year	Iron content of produced water-PPM	Net iron production in lb/day	MPY	Per cent effective	Treating cost in mills	
						Bbl oil	Bbl fluid
No. 1-S	1.2	50.0	2.49	1.99	43	115.9	7.58
No. 2-S	1.2	104.0	5.58	—	0	70.3	6.68
No. 3-S	—	—	—	—	—	—	—
No. 4-S	—	—	—	—	—	—	—
No. 5-S	—	70.9	3.2	2.08	68	72.3	1.61
No. 6-S	—	—	—	2.94	—	—	—
No. 7-S	0.67	26.0	4.1	4.48	75	85.2	1.27
No. 8-S	1.0	29.0	5.1	2.02	54	30.9	2.17
No. 9-S	—	22.2	1.1	3.41	88	66.2	1.93
No. 10-S	—	37.5	2.8	—	40	167.2	4.56
No. 11-S	—	34.2	0.5	—	85	75.4	16.0

SQUEEZE TREATMENT

Well	Tubing failures per year	Iron content of produced water–PPM	Net iron production in lb/day	Per cent effective	Treating cost in mills	
					Bbl oil	Bbl fluid
No. 1-S	—	28.0	0.69	82	50.3	2.39
No. 2-S	1.5	38.9	4.08	0	63.5	2.55
No. 3-S	—	24.0	0.72	84	95.7	2.51
No. 4-S	1.7	44.3	4.3	51	44.2	3.18
No. 5-S	—	21.1	0.58	94	81.5	1.56
No. 6-S	—	20.7*	0.83*	85*	95.8*	2.19*
	—	23.4†	2.3†	58†	33.5†	0.69†
No. 7-S	2.4	33.0	7.8	51	43.6	0.99
No. 8-S	—	22.1	1.6	86	19.6	1.10
No. 9-S	—	20.3	0.51	94	65.8	1.56
No. 10-S	—	23.9	1.0	79	168.0	2.83
No. 11-S	—	21.3	0.47	86	—	—

*Calculated over 2 months period after squeezing.
†Calculated over 5 month period after squeezing.

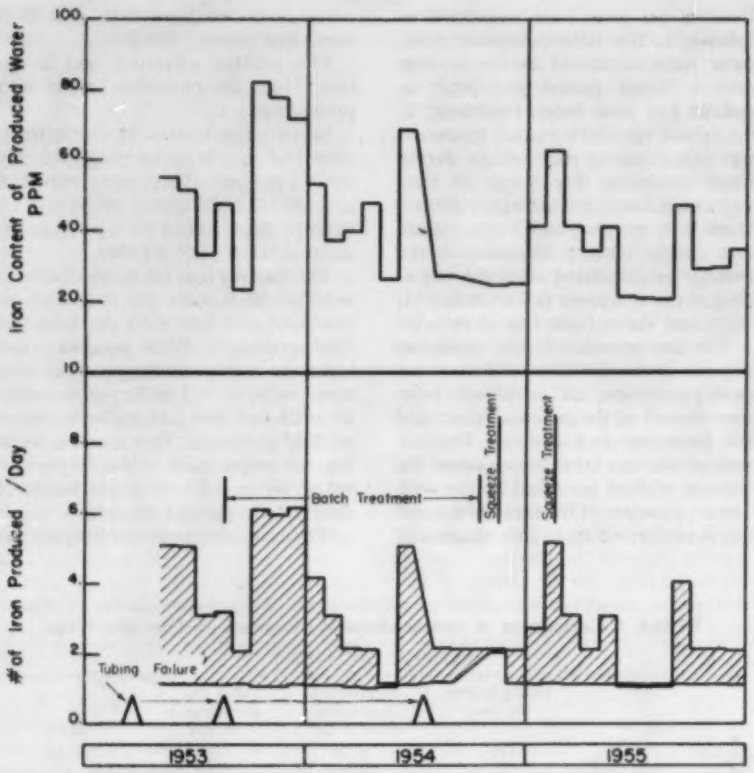


FIG. 3. **Iron content and iron production** from Well 1-S during batch and squeeze treatment.

pounds of iron produced and failure rate brought about an investigation as to the cause of this poor correlation. After considerable investigation of water-sampling techniques and iron-analysis methods, it was found that erratic results of iron analysis were caused by sand present in the sample. When sand was visibly present in a sample, the iron content would be extremely high and would be discarded. However, in many instances, the sample would show high iron content with no visible evidence of sand. It was found that these wells frequently produce a very fine, light sand that would be held in the oil phase and therefore would not be visible.

However, when the sample was acidized and allowed to stand for 12 to 24 hr, the iron content would be high. To ascertain if this was the cause of erratic iron content results, filters were placed on the wellheads of a few wells and filtered and non-filtered samples were taken for analysis. It was found that the filtered samples remained fairly constant in iron content, whereas the unfiltered samples were quite erratic. The filtered samples were always equal to or less than the unfiltered samples. The unfiltered samples would be almost the same as the filtered samples for a period of time, then suddenly the iron content would become considerably greater than the filtered samples for a period of time after which they would come back down to the filtered-sample value. The correlation between net iron production and failure rate is much better when calculated from iron content of filtered samples.

Some well histories. Well No. 1-S. Prior to any chemical treatment, the average iron content of the produced water from this well was 38.0 ppm and the average net iron produced was 3.76 lb per day (see Fig. 3). This well had had 4 failures in 12 months prior to treatment, or an average of 1 failure every 4 months. Batch treatment was started in August, 1953, using 1 gal of chemical with 5 gal of wash fluid daily, which should give a chemical concentration of 85 ppm.

After treating the well at this rate for 10 months, a tubing failure occurred. The failure occurred at a depth of 3200 ft. This treatment extended the life of the tubing by 6 months; however, the iron content was not lowered any appreciable amount. Average iron count during treatment averaged 50 ppm. Batch treatment was discontinued in October, 1954, and the well was squeezed in November, 1954, with 55 gal of water-soluble inhibitor followed by 30 bbl of brine. The iron count was immediately lowered from 50 ppm to 24 ppm, which resulted in a decrease in iron produced of 2.3 lb per day. The iron content remained at about that level for 3 months and then went up quite rapidly to its original figure.

The chemical concentration, as illustrated in Fig. 4, was about 70 ppm 3 days after squeezing and then declined to 0 in 3 months.

The well was then squeezed the second time in February, 1955, using the same chemical but using 45 bbl of brine instead of 30 bbl of brine. Iron content of the produced water did not decline as was expected. However, the well was making some sand and it was believed that this sand was causing the high iron counts. To eliminate the sand, filters were placed on the well and the iron count of these filtered samples went down to 20 ppm. These iron counts remained at 20 ppm until September, 1954, at which time they began to go up to the present 28 ppm. Since the first squeeze job the well has produced 98,480 bbl, or about 36.4 million pounds, of brine. The calculated average chemical content in the fluid is 24 ppm. Chemical analysis of the inhibitor in the well's fluid in November, 1955, and December, 1955, was 50.0 ppm and 22.0 ppm, respectively. Fig. 4 shows the chemical content of the produced water for 3 months after the first squeeze. The well has been produced for 14 months since the

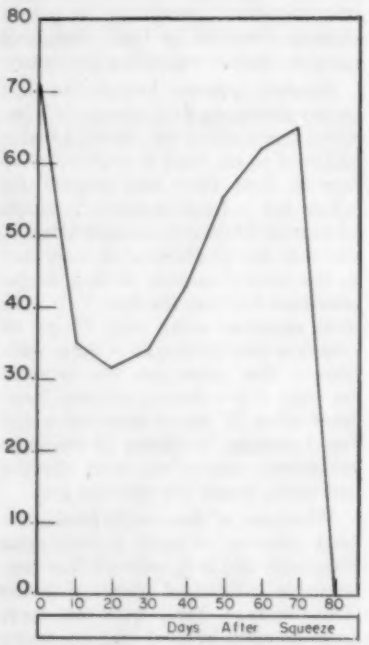


FIG. 4. **Chemical content of produced waters** in Well 1-S in parts per million. For 3 days following squeeze it was 70 ppm; 80 days later it dropped to zero.

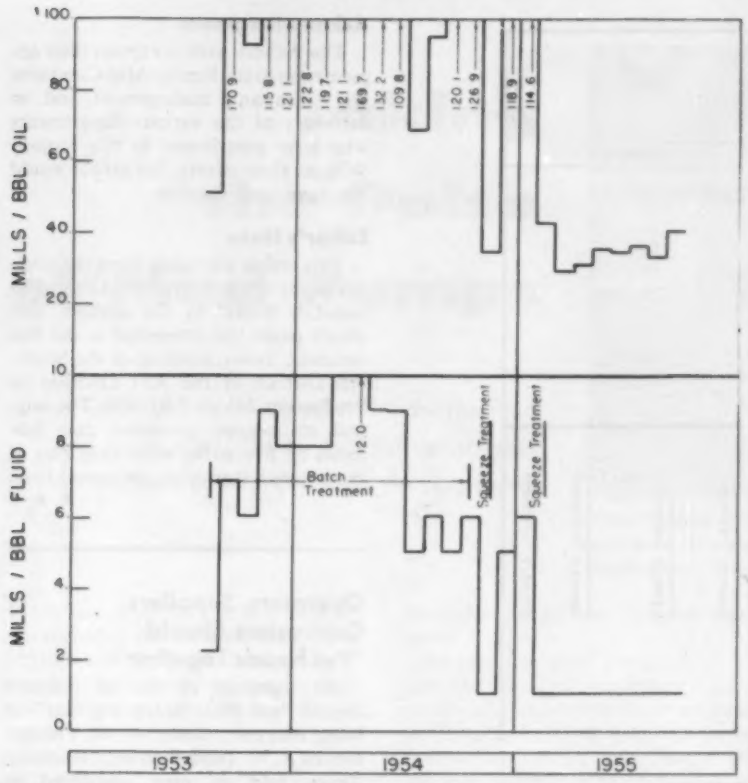


FIG. 5. **Cost of chemical treatment** of Well 1-S shows a reduction of 41.9 per cent for squeeze treatment over batch treatment, and tubing life was extended four months.

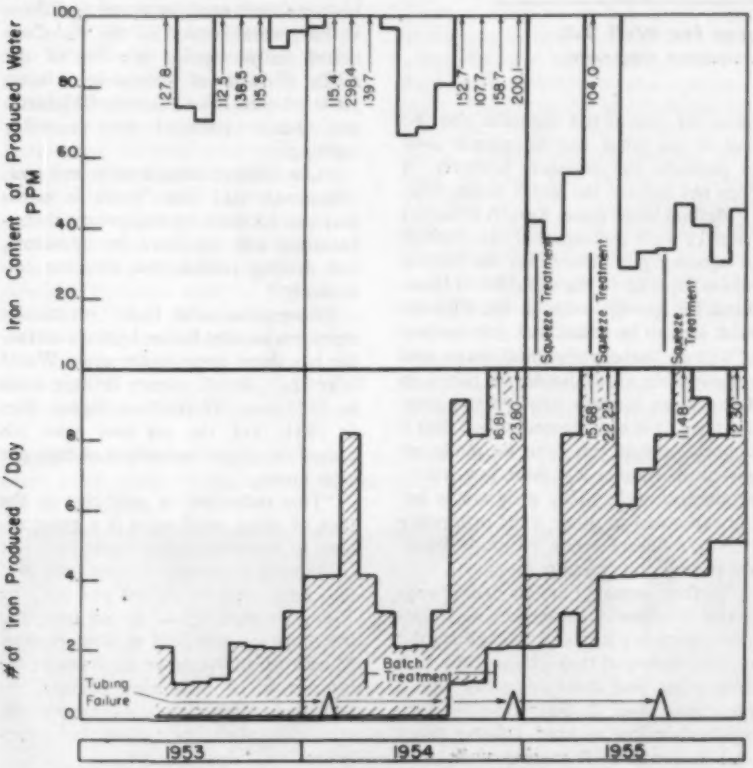


FIG. 6. **Iron content and iron production** from Well 2-S under batch and squeeze treatment.

first squeeze without a tubing failure, which is an increase in tubing life over batch treatment of 4 months. The cost of treatment, as illustrated in Fig. 5, averaged 120 mills per barrel of oil and 7.4 mills per barrel of fluid with batch treatment, whereas the cost by squeeze treatment was 69.2 mills per barrel of oil and 3.1 mills per barrel of fluid produced. The squeeze treatment cost 41.9 per cent of the batch treatment and has given a 4-month longer tubing life.

Well No. 2-S. Analysis of the produced water from this well for iron content was started in May, 1953, and the average iron count in 1953 was 103 ppm. The pounds of iron produced per day in 1953 averaged 1.8. A caliper survey was run in January, 1954, and the entire tubing string was found to be in very poor condition.

The tubing was pulled in February, 1954, and the entire string was replaced with new tubing. Batch-type treatment was started in February, 1954. To start treatment, sufficient chemical was used to give a chemical concentration in the produced water of about 150 ppm. This treating ratio was continued for 2 months without giving much reduction in iron count. The chemical was then increased sufficiently to give about 200 ppm concentration, and the amount of wash fluid used with the chemical was increased from 10 to 84 gal. This treatment was continued for 2 months, which reduced the iron count from 96.0 ppm to 66.0 ppm, a reduction of 30 ppm. The amount of wash water was reduced back to 10 gal per treatment and the chemical concentration decreased gradually over a 4-month period to 20 ppm. Immediately after decreasing the wash fluid and the chemial used, the iron count began to rise until it reached a high of 158 ppm in November, 1954. In December, 1954, the tubing failed and a tubing caliper survey was made. The caliper survey of the tubing showed that 33 joints of the upper 50 joints were badly corroded, 18 of which had been penetrated completely. These 33 joints of corroded tubing were replaced with new tubing.

The well was squeezed in January, 1955, with 55 gal of chemical and 15 bbl of brine in excess of the amount needed to displace the tubing contents. The iron content of the produced water after squeezing averaged 42 ppm, which gave an iron production of 5 lb per day. The iron count remained at about this level for 3 months and then went up to 104 ppm. The well was squeezed again on April 25, 1955, using the same amount of chemical and fluid. The iron count was lowered only a small amount, as shown in Fig. 6.

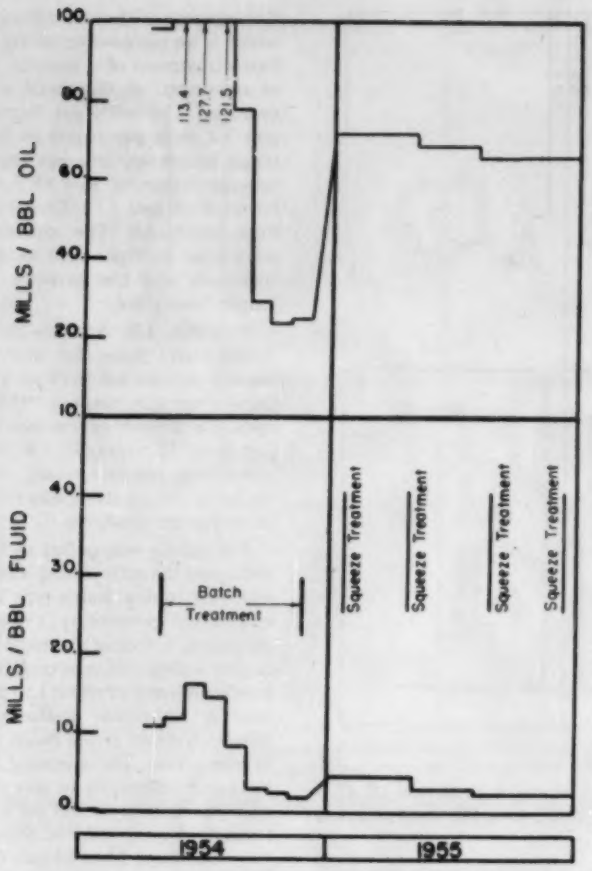


FIG. 7. **Cost of treatment for Well 2-S** for batch treatment versus squeeze treatment.

A filter was placed on the well and the samples taken from this filter showed a large reduction in iron count. The iron count in June, 1955, was 28 ppm and the iron production rate had decreased from 22 to 6 lb per day. The well was squeezed for the third time in August, 1955. Shortly after this squeeze the well was calipered and 4 joints were found with holes. However, the upper 33 joints, the ones that had been installed new just prior to the first squeeze job, showed no evidence of damage by corrosion. The tubing was pulled and 40 joints of badly corroded tubing were replaced. The well was squeezed again on December 8, 1955.

Treating costs in mills per barrel of oil and mills per barrel of fluid are illustrated in Fig. 7 and show that the average cost for batch treatment was 70.3 mills per barrel of oil and 6.7 mills per barrel of fluid. The cost of squeeze treatment averaged 63.1 mills per barrel of oil and 2.5 mills per barrel of fluid. The batch treatment cost is chemical cost only and does not account for the necessary labor and equipment. The squeeze cost is made up of the cost of the chemical plus the cost of the labor and equipment used to perform the squeeze; however, it does not include the well's down time.

Method looks good. Results obtained from 11 wells indicate that this method of squeezing inhibitor into the formation is superior to the usual batch treatment for gas-lift wells in the Placedo field. It is to be noted that this method is still in the experimental stage and considerable care should be taken in doing these squeeze jobs. At the present time, it is not recommended that a squeeze job of this type be made on gas-condensate or low-fluid, low-water-productive wells. This program is being expanded to other wells producing from a different sands and with different production characteristics.

Further work. Further work suggested by these squeeze jobs is: 1. Devise laboratory methods to evaluate the type of chemical that will give the best adsorption and desorption rate for a particular sand; 2. determine the optimum chemical to sand volume ratio; and 3. continue squeezing wells with varying sand characteristics and correlating them to laboratory results.

Acknowledgment

The authors wish to express their appreciation to the Sunray-Mid-Continent Oil Company management and to members of the various departments who have contributed to this project. Without their efforts, this article would not have been possible.

Editor's Note

This article was taken from the original paper titled "Corrosion Control of Gas-Lift Wells" by the authors, and which paper was presented at the San Antonio, Texas, meeting of the Southern District of the API Division of Production, March 7-9, 1956. The original manuscript presented case histories on five wells, while only two of those case histories are presented here.

* * *

Operators, Suppliers, Contractors Should "Put Heads Together"

All segments of the oil industry should "put their heads together" to bring unit costs down, A. W. Thompson, of A. W. Thompson Inc., Houston, Texas, told oil men assembled in Wichita, Kansas, recently.

Thompson, who is vice president for production of the American Petroleum Institute, delivered the opening address at the general session of the Mid-Continent district spring meeting of the API's division of production. Some 1000 oil men from Kansas, Oklahoma and Texas attended the three-day meeting.

As for further reductions in unit cost, Thompson said that "there is much that can be done by equipment manufacturers and suppliers, by operators, and drilling contractors, working collectively."

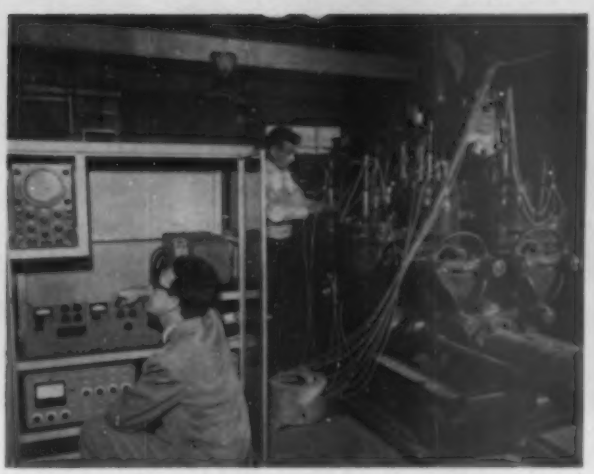
Thompson said that "practically every major cost borne by the contractor has risen consistently since World War II... In all, rotary drilling costs in 1955 were 97 per cent higher than in 1941. Yet, the per foot price tab passed on to the industry was four per cent lower....

"This reduction in unit cost in the face of rising total costs is a great tribute to the contracting industry."

Quoting a recent estimate that 80,000 wells will be drilled per year by 1965, Thompson told the oil men that this "can be accepted as conservative. Moreover, many other analyses of the interaction of increasing demand for petroleum products and increasing difficulty of exploration support this proposition."

Taking the Pulse of Mud Pumps

A close look is being taken inside the fluid end of mud pumps to find out what goes on and how to improve their working parts.



"The Inside Story" of what goes on in the fluid end of a mud pump is revealed by the multi-channel recording oscillograph shown operated by a Mission research engineer at left.

THE "heartbeat" of mud pumps is being recorded for detailed analysis of what goes on inside the fluid end. Purpose of this engineering research project at Mission Manufacturing Company at Houston, Texas, is to improve the working parts of the fluid end of the pump.

Engineers have mounted valve lift pickups on suction and discharge valves and high speed pressure pickups on each fluid chamber from the suction to discharge lines. These pickups are tied into a multi-channel recording oscillograph which photographically plots valve motion and fluid pressure curves as the pump operates at various speeds. Results can be read accurately in increments of thousandths of a second.

The resulting initial curves were surprising even to the research engineers attached to the project. For instance, unexpected sharp pressure peaks, due possibly to some sort of hydraulic resonance, bring up questions which will be the basis of additional research.

Also, viscosity, mud weight, mud temperature, suction piping, and discharge piping affect the pump as does the valve design, liner size and pump speed.

In principle mud pumps today are just like those of yesterday. Today's pumps have more output and are heavier. The fluid end parts have been improved through the years; but so far, the double-acting duplex pump has remained unchallenged in oil field service.

There are several reasons for this. First, nothing better has come along, and it may be that this venerable pump offers the very best solution to the oil field pump problem. Its pumping cycle is simple and reliable in conditions that are most severe. Mud changes in viscosity, weight and temperature from hole to hole and depth to depth. The only constant thing about the volume and pressure requirements of the pump is their wide variance.

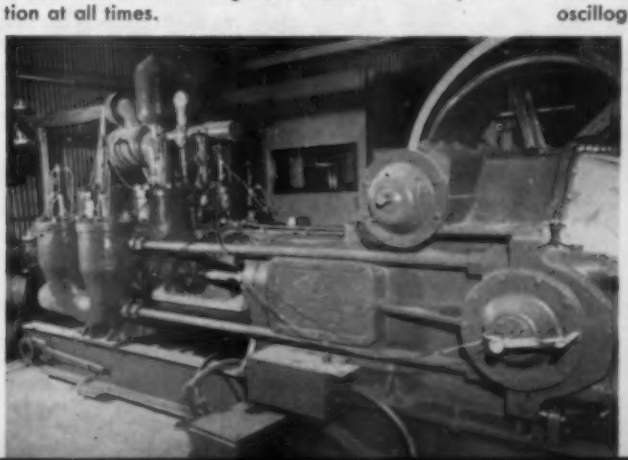
A second reason is that the mud pump is the heart of the drilling rig; and as such, its failure on the job is always costly, sometimes disastrous. The pump must give continuous service for thousands of hours of operation; and when repairs are necessary, they must be made hurriedly with a simple procedure.

All of these factors have taken precedence over efficiency. Fuel for hydraulic horsepower has been a minor factor in the total drilling cost, and most design engineering has been directed at making the pump more reliable and fool-proof. Increased pressure and volume require the maximum output of the pump. Increased competition in drilling requires higher drilling speeds, less down time, and longer parts life.

It has been recognized that to further improve the service life of fluid end working parts, a close study of the exact way they operate is necessary. Objective of this research project is to answer all questions about the hydraulics of a mud pump under both normal and abnormal conditions.

So far Mission has not announced a target date for completion of the project. It is expected to be continued until it shows how to build the maximum service life into the fluid end working parts.

Pump under test. Potentiometer mounted on crank shaft transmits signal to indicate crank position at all times.



Valve lift pickups are mounted in each pot cover. The slightest valve movement is recorded continuously on the oscillograph.

Leasing and exploration are planned in Continental Oil Company's new map room. View pictured is one end of the unique installation, the largest and most modern in the world. The Conoco exploration staff finds the electrically-operated roller maps a big time-saver in making decisions on prospective oil areas.

Map Plotters get 'the Big Picture'

PRESS a button and see the world —in just a few seconds!

It's being done with king-size electrically operated maps—in the Continental Oil Company's map room just completed on the nineteenth floor of the company's new 21-story headquarters building in Houston.

The unique map room is approximately 59 ft long and 30 ft wide. It features walnut-finish metal paneling and at first glance resembles an attractive conference room. But its looks are deceiving.

Recessed in the room's walls are six cases containing 20-ft-wide maps wound on large aluminum rollers. Printed on heavy cloth, the six maps range in length from 150 to 187 ft and are scaled to one inch for every mile. Thus one 20-ft-wide map shows an area 240 miles in width.

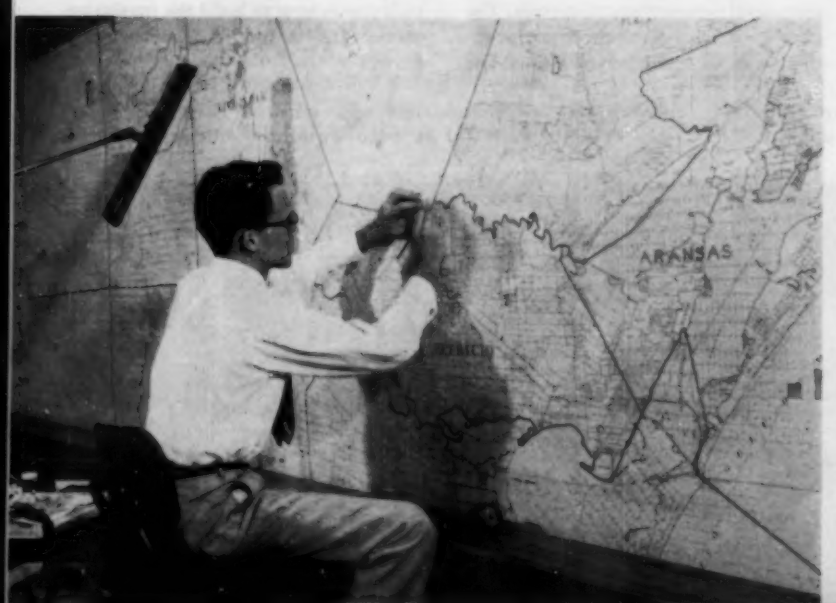
Buttons are spaced a few feet apart and waist-high along the walls. At the touch of a button, rollers spin slowly. In a few seconds, what appeared to be a wall is transformed into a mammoth map. Watching all maps rotate simultaneously is like trying to view a six-dimensional movie.

When installed, the ends of each single map were adjoined by an impregnated cloth the color of the wall panels. Maps not in use are rolled to these sections, which blend with the paneling and help create the conference room effect.

The Conoco maps cover all territories where the company has acreage or wells, including not only the United States but Canada, Egypt, Libya, British Somaliland and Somalia. Four draftsmen work constantly keeping the maps up-to-date, charting the acreage and wells owned by Conoco, other oil companies and independent oil operators.

"The installation is a time-saver in many ways," said H. H. Hinson, vice president in charge of exploration. "We can get a quick overall picture of a prospective oil area, which was not possible with the use of small strip maps. In addition the maps show us instantly the relationship of areas currently receiving an active play from oil operators."

Conceived by Conoco officials who visited the outstanding map rooms in the country, the facility also is the first of its type to be planned prior to the construction of a building. This factor enabled the company to realize economies in installation. ★ ★ ★



Full time job for four Conoco draftsmen is the task of keeping the maps current. Leases, wells and other information recorded by them give exploration men a quick picture of the relationship of areas receiving an active play from oil operators.

Lone Star Cements Protect Billions of Dollars of Oil-Well Investments

● From the shallow wells of yesterday, to today's deepest wells in the Louisiana fields, Lone Star Cements stand staunchly behind millions of feet of pipe, protecting oil-well investments totalling billions of dollars.

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P 500

Selecting a Well Completion Program

Steps in the development of the completion program.... Advantages of completion types.... Factors in selecting equipment.

James A. LeVelle

TRANSFORMATION of a well from drilling effort to a productive unit occurs during the completion of the well. The type completion used and work performed at this time affects productivity and determines to a considerable degree future workover and operating costs. In many cases, it also determines the economic producing life of the well. In view of this, it is considered to be the most critical phase in the development of the well.

Completion operations are defined as those occuring from the time the bit first penetrates the pay zone until the well is placed on production. In this period, the well is drilled in, coring and logging performed, casing or liners set and perforated, and many other operations performed. Selection of the correct completion program will result in a high productivity and satisfactory production operations. Foresight in the layout of the program and equipment will aid considerably in reducing the costs of future recompletions and in re-equipping the well due to future production requirements.

Type completion and operations influence drilling procedures, casing programs and affect the contract well costs. In view of this, the completion program should be developed and decisions made before the well is started.

Since the completion program influences the overall well program, the procedures selected are of major concern to production, reservoir-engineering, and drilling personnel as well as general management. However, due to the technical subjects involved, decisions regarding the various steps in the program are made individually or jointly, among departments depending upon the company organization. In practice, the type completion and bottom-hole setting to be made are generally considered a joint problem of the production engineer, who will produce the well and perform remedial operations, and the reservoir engineer. Hole size or casing to be set in the pay zone is considered a joint problem of producing, reservoir, and drilling since it involves factors concerning all. Well stimulation procedures, perforating, techniques of obtaining formation data are normally designated by the reservoir engineers. Selection of the well completion equipment is normally delegated to decision of the production personnel. Selection of drilling in techniques, squeeze operations, casing cementing, and similar techniques is made by drilling personnel.

Selection of the Completion Program

The primary objective of the completion program is to obtain the most economical completion with the highest productivity and mechanical performance permissible. To obtain these optimum conditions, the program is based upon past experience in the area, good field practice and the careful analysis of present and future well requirements. The order in which the program is normally developed is as follows:

1. Selection of the type completion and bottom-hole setting based upon formation and operating requirements.
2. Determination of hole size or casing sizes required for type completion to be made.
3. Selection of operations to be used and the development of procedure to be used in coring, fracturing, etc.
4. Selection of well completion equipment.
5. Determination of completion costs and economics.

The determination of completion costs and economic analysis plays an important part since costs are reviewed prior to setting the program in action. Where several plans of action or programs appear favorable, the final selection is determined by comparison of costs and the overall economics. In actual practice, the selection of many of the components in the program will be chosen based on reduced costs or improved operating economy.

Upon completion of the well, it is common practice to evaluate the completion and results obtained. This evaluation includes mechanical performance and the initial productivity obtained. The evaluation data obtained are used in planning subsequent completion programs in the field and assist the engineers in the development of improved completion procedures.

Procedures indicated above basically describe the methods employed in proven areas. However, this procedure can be used on wildcat wells where a real geology, knowledge of productive sands, and information from nearby fields or wells can be applied. Where the test will be made on several sands, alternate completion programs may be developed. The final selection being made follows the completion of satisfactory tests.

Types of Completion

The type completion used is determined primarily from the characteristics of the formation, future workovers, and anticipated well requirements. To aid in the presentation of the many factors, the types of completion and the pertinent advantages of each are presented graphically in Fig. 1 and 2. While some 15 types of completions are shown, it will be recognized that many are modifications of basic types. In the producing life of the well, several modifications of the completion may be required to meet production requirements. Where these requirements can be anticipated, the

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type completion is selected from the family of bottomhole settings that most nearly satisfies both future and immediate needs.

Types of setting presented are divided into single and multiple-zone completions, which are further subdivided in regard to the casing set above or through the pay zone and, in multiple-zone completions, as to the type of packer arrangement. Multiple-zone completions are in some degree limited in variations of completion that can be used. The bottom zone may be treated in much the same manner as single completions, with casing set above or through the pay section. Also screens, liners, and other methods can be employed. However, present equipment limits the completion of the upper zone to the conventional perforated-type completion. Use of some forms of gravel pack and screen settings have been attempted but are not sufficiently developed for consideration at this time.

Permanent-type completion techniques, however, have been developed to permit their use on both the upper and lower zones in dual completions. While limited at this time to single-tubing string type installations, developments are underway to extend the use of this technique to the multiple-tubing type completion.

Hole and Casing Size

Since the casing and hole size used in the completion affects the overall well program, affects the drilling program, cost of the well, and future in hole operations, selection is made jointly by drilling, production, and reservoir personnel. Once the type completion is determined, the hole size may be selected based upon drilling practices, required sizes indicated by the type completion to be used, and past experience in the area. In making this selection, the following additional factors should be considered:

1. Possible coring methods.
2. Size required for future liner settings and remedial operations.
3. Where large volumes of fluid may be produced by artificial lift, the sizes of the artificial lift equipment required.
4. If a multiple-tubing type dual completion is to be used, additional clearance may be required to install tubing strings and equipment. The use of two strings of 2-in. tubing requires a 7-in. casing string.

Completion Operations

While the selection of the type completion involved one choice, completion operations indicate a wide variety of operations, which must be integrated into the overall program. Included in this category are all of the functions that take place throughout the completion operation. Procedures include the procurement of data for formation evaluations, selection of drilling in programs, casing cementing operations, perforating, and many other techniques.

Discussion of the advantages and disadvantages of the many operations that are performed is beyond the scope of this article. However, the following outline is provided as a check list in considering work to be performed and its effect upon the completion program.

Formation Evaluation Methods
- Coring
  - Conventional rotary
  - Diamond
  - Wireline
  - Side wall coring
  - Cable Tool
- Drillstem testing
  - In open hole
  - In casing
- Electric logging
  - Electrical
  - Wall micro-resistivity
  - Guard logs
  - Scratcher resistivity
  - Gamma ray
  - Induction
  - Neutron
- Other types of logging
  - Mud logs
  - Temperature
  - Dip surveys
  - Caliper logs

Drilling-in Methods
- Rotary
  - Water based mud
  - Oil-emulsion mud
  - Oil based mud
  - Water
  - Oil
  - Gas or air
- Cable tools

Casing Cementing
- Conventional
- Stage cementing

Perforating
- Jets
- Bullets

Formulation Stimulation Methods
- Hydraulic fracturing
- Acidizing
- Nitro-shooting
- Gun shooting (open hole)
- Mud desolving acids
- Surface-active agents
- Marble shooting

Plug-Back Methods

Squeeze Cementing Methods

Completion Equipment

The equipment used in the completion of the well is generally indicated as surface and subsurface equipment. Subsurface equipment and the sizes that may be installed in the well are dependent upon the type completion made, casing or hole sizes, and in some cases the type of operations used. To this degree, the equipment is selected early in the well drilling program or before the well is spudded. On the other hand, the final choice of surface equipment is delayed in many cases until just prior to the completion operations. A diagram of the same general types of equipment and their advantages and disadvantages is provided in Fig. 3.

Selection of the type of installation and equipment to be used is based upon immediate needs and determination of future well requirements. Many operators have reduced workovers and operating costs by installing pump seating nipples, wire-line set gas lift valves or other equipment for future operations in the completion string. In addition, special multiple-packer installations have been used successfully in short-lift zones to permit the opening of new pays without the need for workovers. The advantages of such preparation in the completion must be determined from study at the individual well.

Evaluation of Equipment

One of the most important operations in the development and selection of completion programs is the evaluation of the performance obtained both from mechanical and productivity aspects. It provides a measure of the success obtained with the types of completion and program used and assists in the planning of suitable procedures for use in subsequent completions. In many cases, it results in the de-

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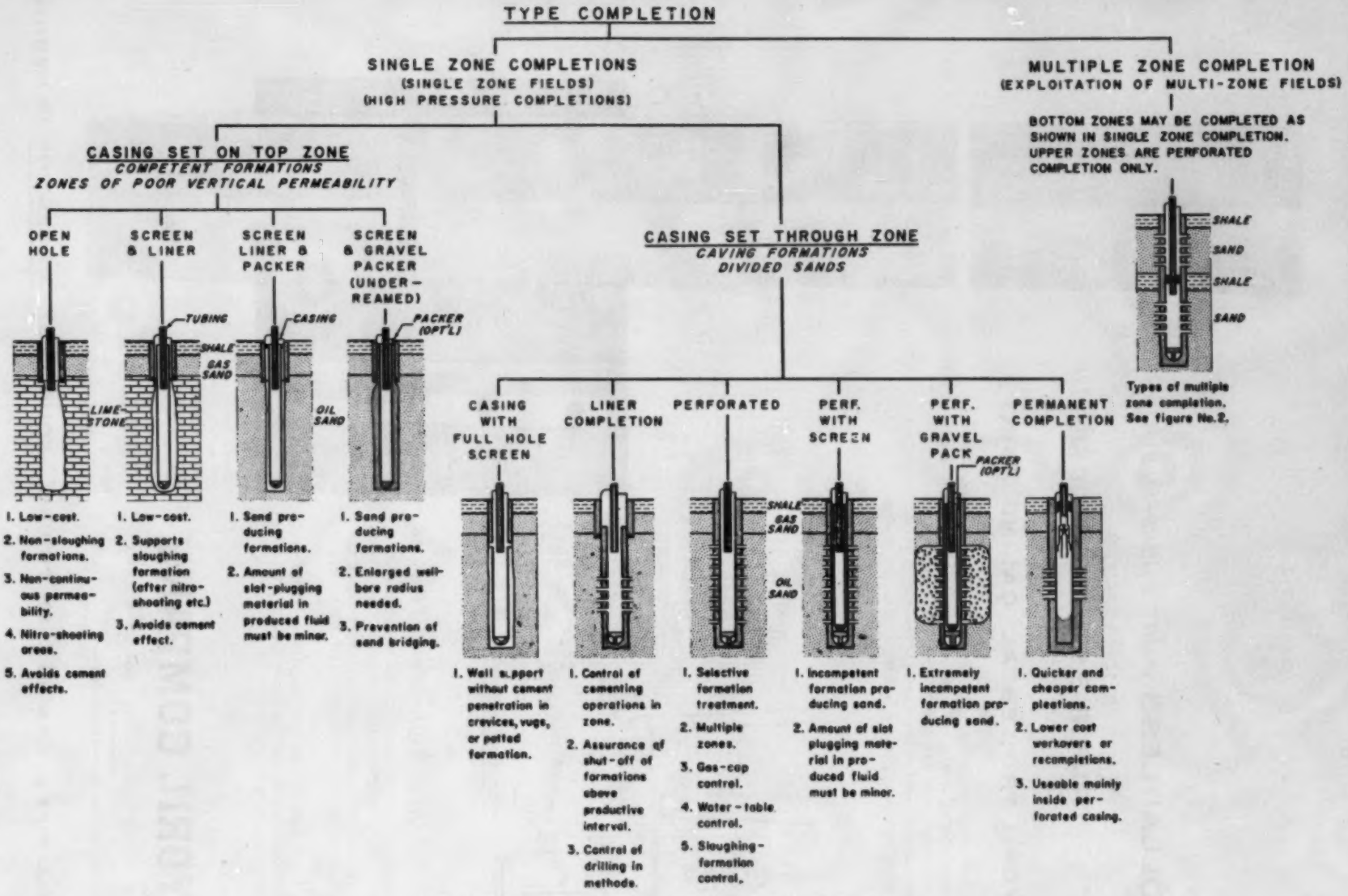

FIG. 1. Selection of type completion and bottom-hole setting.

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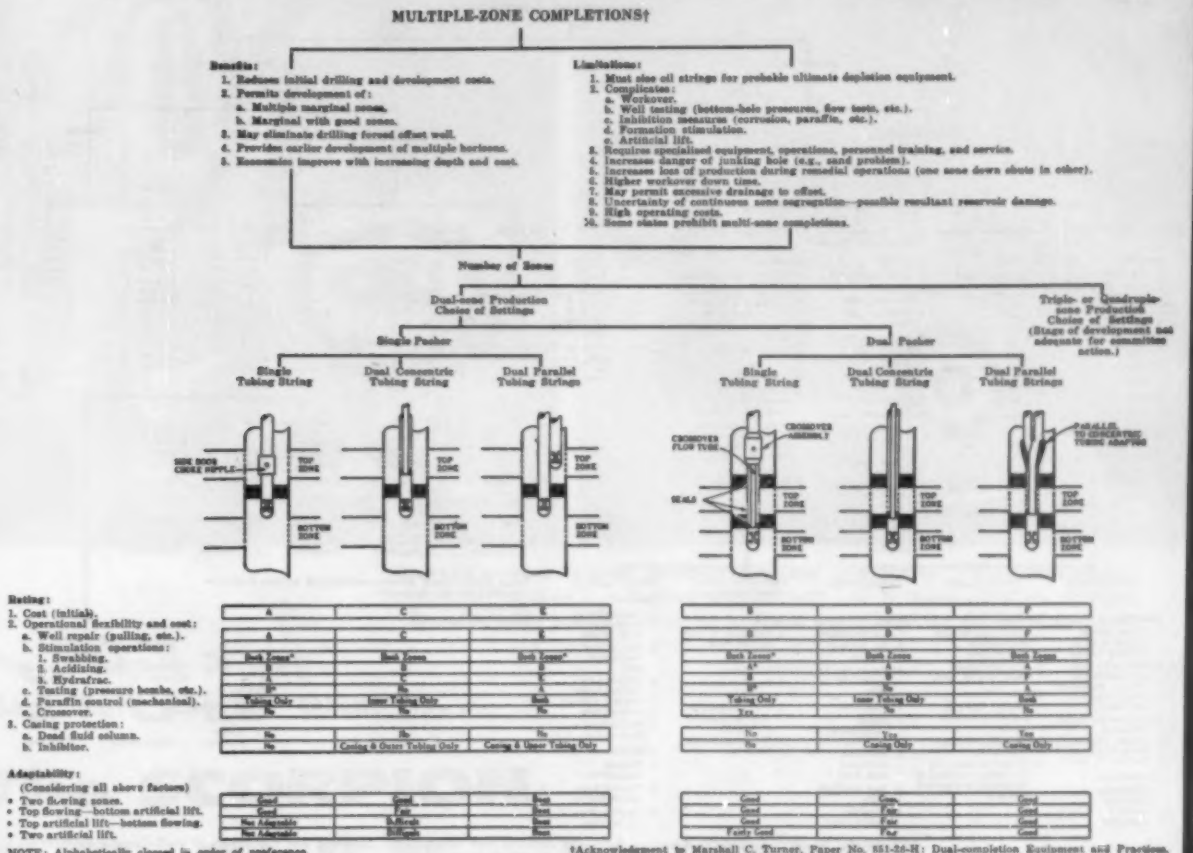
MULTIPLE-ZONE COMPLETIONS†
Benefits:
1. Reduces initial drilling and development costs.
2. Permits development of:
a. Multiple marginal zones.
b. Marginal with good zones.
3. May eliminate drilling forced offset well.
4. Provides earlier development of multiple horizons.
5. Economics improve with increasing depth and cost.
Limitations:
1. Must size oil strings for probable ultimate depletion equipment.
2. Complicates:
a. Workover.
b. Well testing (bottom-hole pressures, flow tests, etc.).
c. Inhibition measures (corrosion, paraffin, etc.).
d. Formation stimulation.
e. Artificial lift.
3. Requires specialized equipment, operations, personnel training, and service.
4. Increases danger of junking hole (e.g., sand problem).
5. Increases loss of production during remedial operations (one zone down shuts in other).
6. Higher workover down time.
7. May permit excessive drainage to offset.
8. Uncertainty of continuous zone segregation—possible resultant reservoir damage.
9. High operating costs.
10. Some states prohibit multi-zone completions.
Number of Zones
Dual-zone Production Choice of Settings
Triple- or Quadruple-zone Production Choice of Settings (Stage of development not adequate for completion notice.)
Single Packer
Dual Packer
Single Tubing String
Dual Concentric Tubing String
Dual Parallel Tubing Strings
Single Tubing String
Dual Concentric Tubing String
Dual Parallel Tubing Strings
SIDE DOOR CHOKE NIPPLE
CROSSOVER FLOW TUBE
CROSSOVER ASSEMBLY
SEALS
PACKER TO CONCENTRIC TUBING ADAPTER
TOP ZONE
BOTTOM ZONE
Rating:
1. Cost (initial).
2. Operational flexibility and cost:
a. Well repair (pulling, etc.).
b. Stimulation operations:
1. Swabbing.
2. Acidizing.
3. Hydrafrac.
c. Testing (pressure bombs, etc.).
d. Paraffin control (mechanical).
e. Crossover.
3. Casing protection:
a. Dead fluid column.
b. Inhibitor.
Adaptability:
(Considering all above factors)
• Two flowing zones.
• Top flowing—bottom artificial lift.
• Top artificial lift—bottom flowing.
• Two artificial lift.
NOTE: Alphabetically classed in order of preference.
*Requires use of wire-line tool to set side door or crossover.
†Acknowledgment to Marshall C. Turner, Paper No. 851-26-H: Dual-completion Equipment and Practices, presented at the meeting of the Mid-Continent District, API Division of Production, March 1954.

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FIG. 2. Selection of types of dual-completion installations.

velopment of new and improved procedures and in the design of more satisfactory completion equipment.

The evaluation of the completion consists of two phases, mechanical evaluation and productivity evaluation.

Mechanical evaluation consists of observing the performance of surface and subsurface equipment and mechanical elements, such as liners and cementing jobs, throughout the productive life of the well. This is accomplished through the maintenance of records concerning equipment life, maintenance costs, corrosion, etc. It also is established in the evaluation of cementing materials, liner operations, and the type of bottom-hole settings through records of failures and effects observed in workovers. For example, difficulties encountered in controlling gas-oil ratios in open-hole completions would alter future well completion programs to provide control or permit improved control methods. Failure or break-down of cements used to set the casing string would result in the selection of improved cementing techniques or better cementing materials.

Productivity evaluation consists of observing the product ability of the formation from flow tests, core analysis, and other well data. The measure of performance is the determination of whether the permeability has been improved or impaired by the completion techniques used. In recent years, it has been found that pressure build-up data provide an excellent measure of the completion program. Several formulas and techniques have been developed to use this data as a measure of productivity.

One method, productivity ratio, is defined as the ratio of actual productivity of the well to the productivity that would exist if the permeability in the well were the same as that in the majority of the drainage area. Other methods include the calculation of skin effect and determination of drainage-area permeability. Each of these methods requires estimation of certain properties of the formation.

Where the productivity evaluation of the completion is correlated with other data in the field, these data will aid effectively in the selection of future operations. This, in addition to the mechanical evaluation of equipment and other operations, determines the completion program that will be used in future completions.

PRESSURE-BUILD-UP TESTS

In order to obtain satisfactory test results, certain precautions should be taken in running pressure-build-up tests. These include the application of well equipment, selection of production rate and the performance of tests. The major precautions which should be observed have been adequately outlined in API Bulletin D 6, *Selection and Evaluation of Well Completion Methods* and are presented as follows:

PRECAUTIONS AND STEPS IN RUNNING PRESSURE-BUILD-UP TESTS

A. Well Equipment

1. Piping manifold, separator, and tank so that production from test well can be measured for at least 24 hours separately from that of other wells on lease.
2. A "swab" valve on Christmas trees so that sub surface-pressure gages may be used in flowing well without shutting in the well.

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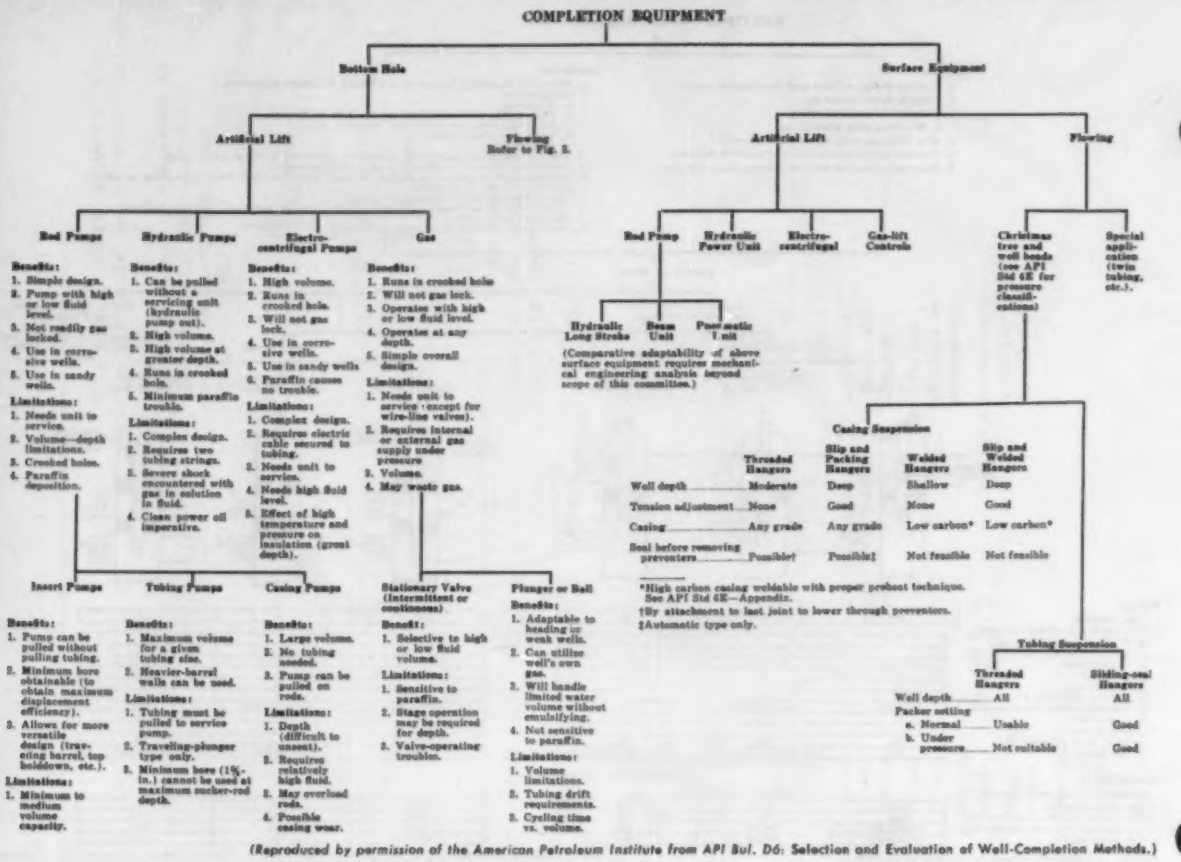
COMPLETION EQUIPMENT
Bottom Hole
Surface Equipment
Artificial Lift
Flowing
Refer to Fig. 2.
Artificial Lift
Flowing
Rod Pumps
Hydraulic Pumps
Electro-centrifugal Pumps
Gas
Benefits:
1. Simple design.
2. Pump with high or low fluid level.
3. Not readily gas locked.
4. Use in corrosive wells.
5. Use in sandy wells.
Limitations:
1. Needs unit to service.
2. Volume—depth limitations.
3. Crooked holes.
4. Paraffin deposition.
Benefits:
1. Can be pulled without a servicing unit (hydraulic pump out).
2. High volume.
3. High volume at greater depth.
4. Runs in crooked hole.
5. Minimum paraffin trouble.
Limitations:
1. Complex design.
2. Requires two tubing strings.
3. Severe shock encountered with gas in solution in fluid.
4. Clean power oil imperative.
Benefits:
1. High volume.
2. Runs in crooked hole.
3. Will not gas lock.
4. Use in corrosive wells.
5. Use in sandy wells.
6. Paraffin causes no trouble.
Limitations:
1. Complex design.
2. Requires electric cable secured to tubing.
3. Needs unit to service.
4. Needs high fluid level.
5. Effect of high temperature and pressure on insulation (great depth).
Benefits:
1. Runs in crooked hole.
2. Will not gas lock.
3. Operates with high or low fluid level.
4. Operates at any depth.
5. Simple overall design.
Limitations:
1. Needs unit to service (except for wire-line valves).
2. Requires internal or external gas supply under pressure.
3. Volume.
4. May waste gas.
Rod Pump
Hydraulic Power Unit
Electro-centrifugal
Gas-lift Controls
Hydraulic Long Stroke
Beam Unit
Pneumatic T unit
(Comparative adaptability of above surface equipment requires mechanical engineering analysis beyond scope of this committee.)
Christmas tree and well heads (see API Std 6E for pressure classifications)
Special application (twin tubing, etc.).
Casing Suspension
Threaded Hangers
Slip and Packing Hangers
Welded Hangers
Slip and Welded Hangers
Well depth — Moderate — Deep — Shallow — Deep
Tension adjustment — None — Good — None — Good
Casing — Any grade — Any grade — Low carbon* — Low carbon*
Seal before removing preventers — Possible† — Possible‡ — Not feasible — Not feasible
*High carbon casing weldable with proper preheat technique. See API Std 6E—Appendix.
†By attachment to last joint to lower through preventers.
‡Automatic type only.
Tubing Suspension
Threaded Hangers
Sliding-seal Hangers
Well depth — All — All
Packer setting
a. Normal — Usable — Good
b. Under pressure — Not suitable — Good
Insert Pumps
Tubing Pumps
Casing Pumps
Benefits:
1. Pump can be pulled without pulling tubing.
2. Minimum bore obtainable (to obtain maximum displacement efficiency).
3. Allows for more versatile design (traveling barrel, top holddown, etc.).
Limitations:
1. Minimum to medium volume capacity.
Benefits:
1. Maximum volume for a given tubing size.
2. Heavier-barrel walls can be used.
Limitations:
1. Tubing must be pulled to service pump.
2. Traveling-plunger type only.
3. Minimum bore (1½-in.) cannot be used at maximum sucker-rod depth.
Benefits:
1. Large volume.
2. No tubing needed.
3. Pump can be pulled on rods.
Limitations:
1. Depth (difficult to unseat).
2. Requires relatively high fluid.
3. May overload rods.
4. Possible casing wear.
Stationary Valve (Intermittent or continuous)
Benefit:
1. Selective to high or low fluid volume.
Limitations:
1. Sensitive to paraffin.
2. Stage operation may be required for depth.
3. Valve-operating troubles.
Plunger or Ball
Benefits:
1. Adaptable to heading or weak wells.
2. Can utilize well's own gas.
3. Will handle limited water volume without emulsifying.
4. Not sensitive to paraffin.
Limitations:
1. Volume limitations.
2. Tubing drift requirements.
3. Cycling time vs. volume.

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FIG. 3. Guide to the selection of well completion equipment.

3. Valves on Christmas tree and tubing that have openings large enough for passage of subsurface-pressure gages.
4. Gas-measuring equipment for gas-oil ratio determination.

B. Production Rate

1. Select a rate which gives a pressure drawdown that can be measured accurately with subsurface-pressure gage.
2. Coordinate test-production rate with proration schedule for the lease.
3. Permit well to flow undisturbed at test rate for a sufficient time to insure stabilization.

C. Pressure-Build-up Tests

1. Measure production rate at start of flow to stabilize the well. Measure production rate and gas-oil ratio for at least 24 hours for the test well near the end of the stabilization period. If a test separator is used, operate the test separator at the same pressure as the separator through which the well was producing during stabilization.
2. Measure flowing pressure near the productive horizon in the well.
3. Shut in the well with subsurface-pressure gage at pressure-measuring station.
4. Continue measuring pressure until end of pressure build-up (usually from 24 to 72 hours are required for test).

The above precautions and running procedures apply to the normally completed well. Where storm chokes, bottom hole regulators and other tubing tools are used additional precautions should be observed to assure that pressure bombs can be run to the desired depth and that restrictions through wire line equipment will not restrict flow. In some cases it will be found expedient to reduce the flow rate in order to obtain satisfactory results. Due to their construction and operation bottom hole regulators must be removed in nearly all cases before running tests.

References

Johnston, Norris, and Sherborne, J. E.: Permeability as Related to Productivity Index, *Drilling and Production Practice*, 66 (1943).

Muskat, Morris: *Flow of Homogeneous Fluids Through Porous Media*, McGraw-Hill Book Company, Inc., New York, 1937.

Miller, G. C.; Dyes, A. B., and Hutchinson, C. A., Jr.: The Estimation of Permeability and Reservoir Pressure from Bottom-Hole Pressure Build-up Characteristics, *J. Petr. Tech.*, 2, 91, April (1950).

Miller, G. C.; Dyes, A. B., and Hutchinson, C. A., Jr.: Application of Build-up Curves To Determine Reservoir Pressure and Permeabilities, *Pet. Engr.*, 22, B-7, June (1950).

Horner, D. R.: Pressure Build-up in Wells, Third World Petroleum Congress, The Hague, 1951, *Proc., Sec. II, Drilling and Production*, pp. 503-521.

Thomas, G. B.: Analysis of Pressure-Build-up Data, *J. Petr. Tech.*, 198, 125, April (1953).

Van Everdingen, A. F.: The Skin Effect and Its Influence on the Production Capacity of a Well, *J. Petr. Tech.*, 198, 171, June (1953).

Hurst, W.: Establishment of the Skin Effect and Its Impediments to Fluid Flow into a Well Bore, *Pet. Engr.*, B-6, Oct. (1953).

Joers, John C. and Smith, R. V.: Determination of Effective Formation Permeabilities and Operation Efficiencies of Water-Input Wells, *Pet. Engr.*, B-82, Oct. (1954).

Mathews, C. S., Brans, F., Hazebrock, P.: A Method for Determination of Average Pressure in a Bounded Reservoir, *J. Petr. Tech. (T.P. 3876)*, 35, Aug. (1954).

Arps, J. J. and Smith, A. E.: Practical Use of Bottom-Hole Pressure-build-up Curves, *Drilling and Production Practice*, 155 (1949).

Van Everdingen, A. F. and Hurst, W.: The Application of the LaPlace Transformation to Flow Problems in Reservoirs, *J. Petr. Tech.*, 1, 305, Dec. (1949).

Dunson, H. M. and Eckel, J. E.: Organization of Procedure for Selecting Well-Completion Methods, Paper No. 851-28-E, presented at spring meeting of the Mid-Continent District, API Division of Production, March 17, 1954.

Wilson, C. L., Smith, R. V., Hendrickson, G. E., and Stafford, J. D.: Evaluation of Well Completions, Paper No. 851-29-F, presented at meeting of the Mid-Continent District, API Division of Production, March 24, 1955.

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Zapata's new tripod mobile drilling platform, "The Scorpion," arrives on location in a floating position with 140-ft spuds elevated. At right, "Scorpion" lifts itself up some 40 ft above water level for drilling operations.

The Offshore Drilling Fleet Gets Another Giant as . . .

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The SCORPION Drills Well Number One

Zapata Off-Shore Company's new tripod, self elevating mobile drilling platform takes on its first job

Donald M. Taylor
Gulf Coast Editor

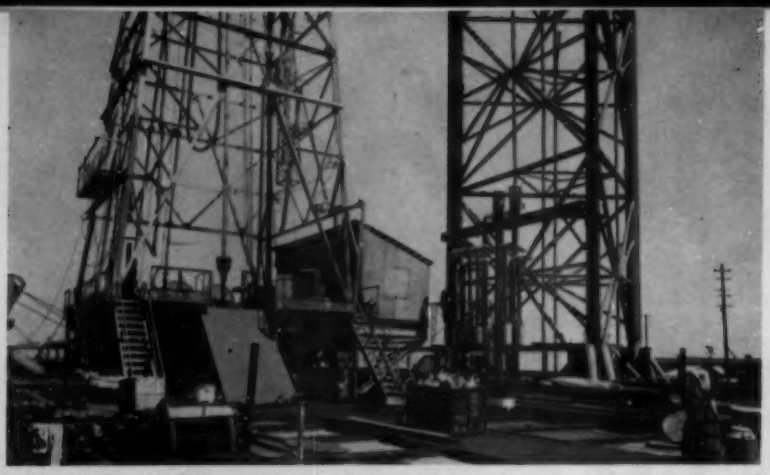
ONE of the newest innovations in mobile drilling platform design is that of Zapata Off-Shore Company's "The Scorpion", christened March 20, 1956, at Galveston, Texas. The following day, the much-talked-about structure was loaded with materials and supplies and was under tow on its way to location 1½ miles off Padre Island near Corpus Christi, Texas. This 200-mile sea voyage was made in about 60 hours. On State Lease 932, it is drilling the first well in 46 ft of water for The Standard Oil Company of Texas. The unusual platform was designed and fabricated by R. G. LeTourneau, Inc., at Vicksburg, Mississippi, and towed to Galveston for outfitting with drilling equipment by U. S. Steel Corporation's Oil Well Supply Division.

Representing a total investment of about $3,000,000, the "Scorpion" is the first three-legged mobile platform to join the industry's growing offshore drilling fleet. It is designed to operate in waters ranging up to 80 ft in depth and to take the full force of the open Gulf waters during hurricane conditions. The three legs or spuds are 140-ft long and are of open web tubular construction offering little resistance to pounding waves. Each spud is a tripod itself, being triangular in cross section. A gear track is attached to each leg of the spud. Gears operate on these tracks to raise and lower the platform. A pontoon tank forms the footing at the bottom of each spud. Gear racks on the legs extend onto the pontoons to permit raising them into a spud well when the barge is underway. Once at a new location, these gear devices lower the spuds to the bottom and can raise the barge above the water surface at the rate of about 10 ft per hour.

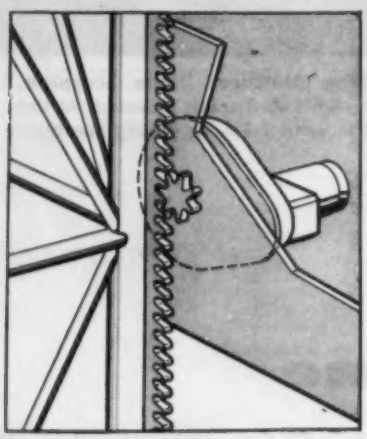
So far, performance of the "Scorpion" has been very satisfactory. When it reached the buoy marker at its first drill site, the hull was raised some 11 ft above water level. A 30-inch conductor pipe was spotted beneath an electric-winch operated drive hammer and the casing driven deep into the Gulf floor. A drill nipple was welded on top of the conductor pipe and the "Scorpion" elevated itself to its normal operating height of 40 ft above water level. Drilling started immediately. This speed of moving and spudding-in is seldom equalled on land.

While the new barge has yet to weather a full size Gulf storm, its owners are optimistic regarding its ability to do so. In a recent mild disturbance, 12-ft seas rolled past the "Scorpion" with very little resistance due to the small cross section of the spud construction.

General platform description. The mobile platform has over half an acre of deck area built above a huge U-shaped tube. Inside these giant tubes which make up the "U" are mud tanks, water storage compartments, diesel fuel, drill water, mud storage tanks, electric generator rooms and mud laboratory. For the most part, the open space in the "U" is decked and in this



Main deck of offshore giant offers ample storage area. Open truss spud shown in background in elevated position. Note gear tracks on each leg of spud for elevating and lowering platform.



Spud movement is accomplished by gear-motors operating on gear tracks on each corner of a spud leg. There are seven gear-motors on each corner, totaling 21 such units per spud; 63 for three spud legs.

area are located the drawworks, main engines, mud pumps, bulk mud hopper and dry mud storage. On the main deck above is located the living quarters (2 decks) to accommodate 46 men, two 250-ft-ton cranes, pipe racks, catwalk, storage area and substructure for the derrick.

Overall length of the barge hull is 150 ft, and when the end spud housing is included, it is 185 ft long. Actual width of the hull is 80 ft, but measuring from outside of both side spud housings, the overall width is 150 ft. The hull is 20 ft deep and, when fully loaded, has a draft of 11½ ft. It has a displacement of 4000 tons and the platform alone without drilling equipment and supplies has a dead weight of 2000 tons.

Raising and lowering platform. Each of the three spuds operate in what is called spud wells located outboard on the two sides and the aft end. Elevating and lowering the spuds and the platform is handled by electric gear-motors mounted in the spud wells. There is a gear track on each of the three legs of each spud. Operating on each gear track are seven gears driven by motors. For each of the three triangular spuds, there are 21 gear motors, making a total of 63 gear motors in all. The final drive pinions of these units mesh with the gear tracks on the triangular shaped legs. All motors have integral motor-load brakes that set mechanically when electric power is cut off, and release electrically when power is applied. These gear-motors are accessible through water-tight hatches on the deck.

When the platform is being raised above water, the 21 motors at each spud leg alternately raise that corner of the platform about six inches. After a six-inch movement at one spud, a six-inch lift is made on another spud, and so on until the platform is raised to its desired height above water. Reason for this alternate raising and lowering procedure is that only those gear motors on one spud require power at any one time. By employing such a method, the total power requirements during the raising and lowering operation are reduced to one-third that which would normally be required should all gear motors at each of the three spuds operate at the same time.

Electrical power for operating the legs and elevating and lowering the platform is supplied by four diesel engine-driven a-c generators. These power units also furnish electrical power for operating the two 250-ft-ton revolving cranes and the three electric winches mounted on the platform deck. The engine generator sets are located in the starboard tube of the barge structure. Spud operation and platform elevation are controlled from the operator's control station above the crew's quarters. As the barge is raised by an operator, he watches a trim indicator which tells him whether or not the barge is seriously out of level. Once the barge is in place and should it lose its trim, the appropriate leg can be lowered or raised to level the platform.

How platform is supported. At the bottom of each of the truss-braced spuds is a 35-ft diameter steel tank with a ¾-in. thick bearing plate on bottom. Top and bottom of the tank are convex in shape. These pontoon tanks are usually filled with fresh water and the difference in density between the fresh water and salt water gives a slight positive buoyancy. They are never purged with air for purposes of buoyancy.

Each of these pontoon tanks has a bearing surface of about 1000 square ft, and in ordinary soil conditions they can easily support a maximum load of 9,000,000 pounds.

Freeing pontoons from mud. So far, there has been little indication that any of the three pontoon feet will become stuck in the mud bottom. However, should there be a tendency for the tanks to become stuck in the mud making it difficult to fully retract the spuds, a water line connects into the apex of the inverted conical bearing surface on bottom. Water pressure at 50 psi can be jetted beneath the tank, exerting an upward force of some 7,200,000

Main drawworks located below deck with engines, compound and mud pumps. They are protected from salt spray. Unit is 4 ft off-center from normal position to allow drilling line to feed up one side of derrick.

Engines and compounds below main deck. When drilling, two of the four engines drive each of two 925-input-hp mud pumps.

Driller's console on main deck affords complete control of entire drilling operation. Drawworks brake is mechanically linked to unit below deck.

lb to free the tank-like foot from the suction of the mud.

Drilling Equipment

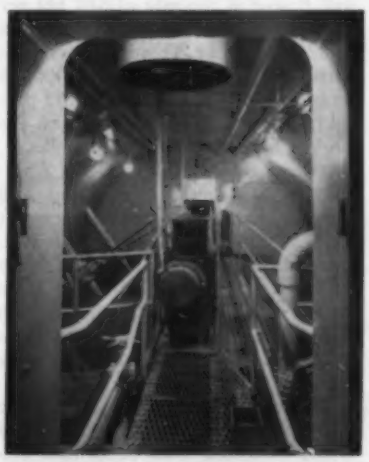
Much of the drilling rig was especially designed or hooked up for the "Scorpion." One of the unusual features of the rig is the location of the main drawworks. It is anchored below the main deck protected from salt spray and is located about four feet to one side of center between two derrick legs (as in conventional practice). The drilling line runs up and off-center inside the derrick to avoid interference with pipe or tools pulled through the derrick vee. For this reason, one of the crown block sheaves was set at an angle in order to thread the line onto the crown.

The main drawworks is an Oilwell "96" equipped with a Parkersburg 60-in. hydromatic brake. A Brantley automatic drilling control is incorporated in the drawworks hookup.

Catworks. A small drawworks is located on the derrick floor and it serves as a sand reel unit. Is is separately powered, and performs all cathead operations as well as drives the rotary. By doing these jobs that require considerably less power, the smaller unit saves wear and waste of power in the large drawworks.

Engines. Four General Motors 110 twin diesel engines furnish power for hoisting and driving the two heavy-duty pumps. These engines are tied into the compound which includes a fifth shaft with a master compounding clutch. By disengaging the pump clutches and engaging this master clutch, preparations to hoist are minimized and controlled entirely from the driller's position. All clutches are gap mounted to facilitate replacement, and the drive shafting removes vertically from the compound case.

Pumps. Two Oilwell 818-P slush pumps, each rated at 925-input-hp at 65 rpm, provide the hydraulic power required for deep drilling. During drilling operations, two of the four diesel engines are compounded into one pump, and the remaining two compounded into the second pump. All pumps, as well as engines and compound are located below the main deck behind the drawworks.



Mud tanks are located in port side of huge U-shaped tubular hull resembling interior of submarine. Note electric-driven mud agitator on walkway.

Drilling controls. All drilling operations are controlled by the driller from his position on the derrick floor. He has communications to all parts of the rig, including the derrickman, and from his derrick-floor console can control all drilling operations, including the engines, pumps, automatic feed control, hoisting from below deck, catheading and rotary table speed.

Mud storage. All mud storage, both bulk and in sacks, reserve mud tanks, pits, etc., are located below the main deck. There is storage for 4500 sacks of bulk mud, and about 6000 sacks of mud in 100-lb sacks. Mud is mixed by electrically-driven agitators. Mud returning from the well enters degassing and/or desanding equipment.

Blowout preventers. These units vary from well to well, but the rig is equipped for the ultimate in blowout prevention and control. On the derrick floor just a few steps from the driller's console are all remote control valves for the blowout preventer hookup. On the first well, three Cameron units and one Hydril preventer were used.

Auxiliaries. Electric-powered winches are used as much as possible, even to drive the conductor pipe. The rig has an automatic stabbing board designed to withstand up to 125-mile an hour wind in the open Gulf.

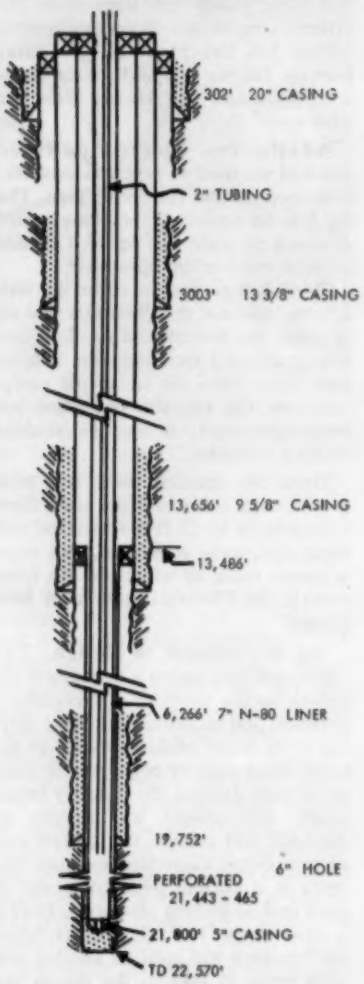
Derrick floor moves. After the well is completed and the Christmas tree set in place, the derrick and rig floor section is winched from over the hole by wire lines. Since the weight of equipment on the movable rig floor has been minimized, it can be skidded without difficulty.

Once the derrick floor has been moved back from over the hole, there is an area 24 by 28 ft in which the well head equipment is located, and there is ample room to winch the rig from around the Christmas tree with little danger.

An experiment in design. The "Scorpion" represents a brand new approach to the problem of designing a practical and economical unit for drilling wells in the offshore waters of the Gulf. Since activity began accelerating in offshore drilling, the industry tenaciously has sought to improve its methods and reduce the overall cost picture. Some authorities estimate that there is a current need for some 70 such mobile drilling platforms. Here is a new one to look at, and its future performance will indicate another possible route to take in the design and construction of such structures. Undoubtedly, it will afford the industry another chance to evaluate a new approach to the problems of drilling wells in unprotected waters. ★ ★ ★

Richardson & Bass wildcat produces 38 deg crude from perforations at 21,443-21,465 ft, 3871 ft below previous record held by Shell at Weeks Island, Louisiana. Low GOR test explodes theories on deep production.

World's Deepest Well Now Deepest Producer



Completion program for world's deepest producer and deepest well ever drilled.

COMPLETING more than a year of drilling, the Richardson and Bass wildcat, located 35 miles south of New Orleans in the Lake Washington area, was completed in perforations 21,443-465 ft and placed on test April 22. Flowing 38 deg API gravity crude with a low gas-ratio, the discovery deviates from the South Louisiana theories that indicate only gas or gas-distillate production would be found at great depths.

It is anticipated that the geologic and engineering information gained in this exploration of the thick miocene sediments to these great depths and the resulting production will aid materially in future deep well operations.

Reports indicate that on 2-hour test, well flowed at the rate of 510 bbl per day with a gas-oil ratio of 1175 to 1 on an 8/64-in. choke. Tubing pressures reported to be 6500 psi with a 5400 psi pressure in the casing annulus. If production is sustained, well will be the world's deepest commercial producer, exceeding by 3871 ft Shell Oil Company's C. B. Patout et al No. 1 well completed in a gas-distillate zone at 17,572 ft in the Weeks Island field. Deepest production found prior to the current test was at 17,500-859 ft in Richfield Oil Company's well in North Coles field, California. This well has since been recompleted in shallower sands.

The wildcat, Humble L L & E State 2414 No. 1-L, is a joint venture of Richardson and Bass (Louisiana Account), John W. Mecom of Houston, and Freeport Oil Company, a division of Freeport Sulphur Company. The well was drilled to a total depth of 22,570 ft, 1088 ft deeper than the previous record set by Ohio Oil Company in their KCL A 72-4 well in the Paloma field, California. Drilled by Richardson and Bass Rig No. 25, a barge mounted unit, well has required 14 months to completion and is reported to cost in excess of $2,400,000. Mud materials required to maintain the high mud weights required were reported to cost approximately three-quarters of a million dollars.

Spudded February 27, 1955, the well was bottomed at 22,570 ft some 300 days later. High pressures encountered required mud weights from 18 to 18.5 lb per gal and high temperatures up to 350 F required closed control of mud properties. The successful drilling program has been largely attributed to excellent mud control and the use of advance mud handling equipment to control gas cutting.

Drilling rates progressively reduced as the hole was drilled deeper. The last 1000 ft was made at the torturous rate of only 30 to 35 ft per day. 107 bits were used in the drilling program. Casing used in the drilling of the well included 302 ft of 20-in., 3003 ft of 13⅜-in., 13,656 ft of 9⅝-in. P 110 and N-80 casing and a 7-in. liner which was bottomed at 19,752 ft. The well was completed with a 5-in. liner sent to 21,800 ft which was later topped out with a full string of 5-in. casing to the surface.

The 5-in. casing used is 26.4 lb P-110 casing equipped with special threaded couplings. Casing string has been tested to 18,000 psi hydrostatically. ★ ★ ★

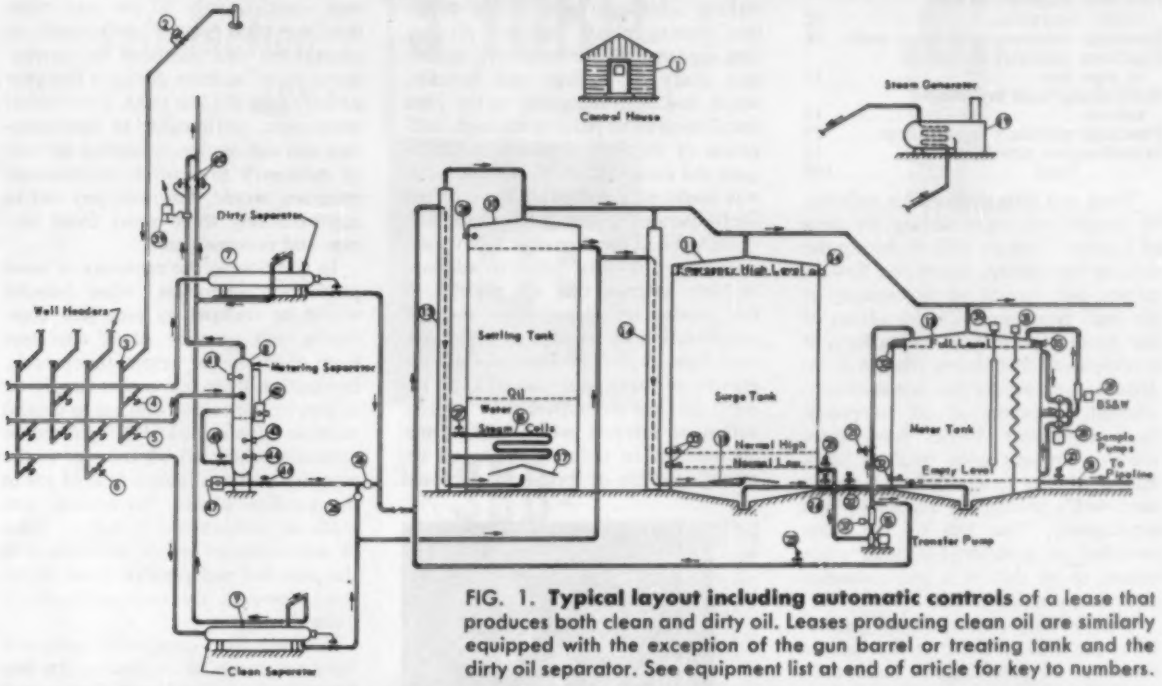


FIG. 1. **Typical layout including automatic controls** of a lease that produces both clean and dirty oil. Leases producing clean oil are similarly equipped with the exception of the gun barrel or treating tank and the dirty oil separator. See equipment list at end of article for key to numbers.

Research and Development Increase Efficiency in . . .

Automatic Lease Production System

The Wasson field of Yoakum and Gaines counties in West Texas is Shell's proving ground for automation in production. Here's the latest installation.

R. L. Geer and D. C. Meyers
Shell Oil Company
Midland, Texas

IN the basic problem — how can present crude oil and gas production methods be improved? — there are several fundamental operations that must be performed in the production and transfer of hydrocarbons from the producing lease to the purchaser.

At the outset of this development program, a study was made of lease production methods in order to discover where operating efficiency could be improved in performance of the various functions of oil and gas production, viz.: (1) Control and schedule well production; (2) conduct periodic well-performance tests; (3) perform functions necessary for separation and storage of gas and oil production; and (4) run, measure, and witness transfer of crude oil from lease storage to the pipe line.

The lease switcher's activities also were observed. It was disclosed that the average lease switcher or pumper spent one-third of his time driving from point to point on the lease, and the remaining time was largely spent performing repetitious routine operations, such as turning wells on and off, switching tanks, gaging tanks, witnessing pipe line gager measurements, etc. Assuming that these duties included only the operation of equipment necessary to produce the lease, i.e. no repair or maintenance work, it was observed that the switcher's total time, including driving, is occupied as follows:

*Paper presented at the spring meeting of the southwestern district of the API Division of Production, Fort Worth, Texas, March 21-23, 1956, under original title: "Automatic Lease Production, Wasson field, Texas."

	Per Cent
Functions necessary to tank-battery operation	22
Functions necessary to produce wells	18
Functions necessary to run oil to pipe line	15
Maintaining lease production records	10
Functions necessary for well tests	25
Miscellaneous activities	10
Total	100

There was little concern for switcher or pumper efficiency during the days of Colonel Drake's well or during the days at Spindletop, where the flow of oil was only limited by the capacity of the well. However, with the advent of our present petroleum technology, it is recognized that proper control of individual-well production is essential to efficient operation of oil reservoirs. State regulatory bodies have since made it not only good business but a matter of law to control and record each well's production accurately and intelligently. The job of the lease switcher or pumper has long since ceased to be that of a mere watcher over earthern pits of oil.

This investigation of actual manual labor required to perform the various functions of producing a lease indicated that a great percentage of these functions could be duplicated by automatic devices and instruments. Thus, automation would permit the lease switcher or pumper to utilize his time more efficiently in the intelligent pursuit of more profitable production problems that confront oil producing companies.

Pilot system installed. After investigating automatic devices that had been used successfully in North and East Texas fields by others, as well as devices that could be adapted for use in reducing the time consumed by the lease switcher in performing certain lease functions, a pilot installation was made. It consisted of time-cycle controls from a central point for 5 flowing wells, automatic tank filling and emptying to measure gross oil volumes, instruments to record the physical properties of the crude oil, and safety devices to shut in the wells in the event of a power failure or malfunction of equipment. Information gained from the early surveys and tests of the pilot installation indicated the potentiality of automation because nearly all functions concerned with lease operation could be performed automatically by controls and instruments with only a very minimum of manual effort required.

Advantages of program. The Shell-operated leases in the Wasson field of West Texas were selected as the most desirable for initiation of such a program because of the greater number and concentration of wells and the immediate need of replacing many of the lease storage facilities and need for installing additional well-testing facilities, treating plants, and well-production equipment. An extensive economic study of savings and benefits, which had been indicated by the pilot installation to be possible through utilization of the new production techniques and automatic-control equipment, was made on a field-wide basis of the Shell-operated leases in this field.

Included in the economic study were savings and revenue gains, in addition to labor savings, that are possible to the production department through minimization of paraffin in high-pressure flow lines and increases in the gravity of stock-tank oil (0.5 to 1.0 API) that are accompanied by conservation of reserves which will permit an increase in ultimate crude oil recovery. Results of this study disclosed

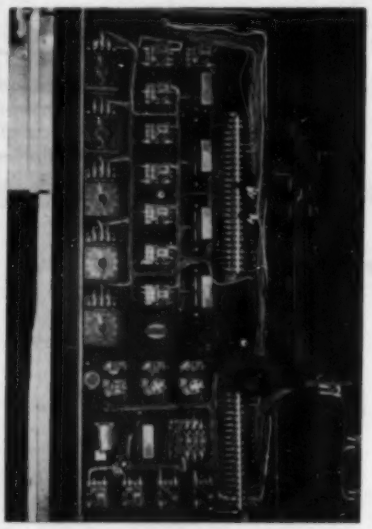


FIG. 2. **Master lease controller** for controlling automatic tank battery operations.

FIG. 3. **Well flow and test control** panel for four wells.

that conversion of 29 leases in this field-wide automation project would cost approximately 50 per cent more than the total cost of anticipated replacements and additions to conventional lease facilities during a five-year period from 1953 to 1958. This capital investment, attributable to centralization and automation, including the cost of necessary preventive maintenance program, would, however, pay out in approximately three years from savings and revenue gains.

In addition to the economy of lease production operation, other benefits would be realized by pipe line companies and gasoline plant operators from utilization of automatic controls. Production from leases that supply oil to pipe line terminals and gas to central gasoline plants could be regulated to maintain scheduled oil transfer to the pipe line and continuous flow of gas to the gasoline plants. No attempt was made to evaluate the monetary value of centralization and of automation to the pipe line and gasoline plant operators. However, the savings should be quite sizeable.

A design for a completely automatic lease was made, incorporating the best features of previous installations as well as new and original ideas that more or less evolved as the design problem was attacked. This design gave promise of worthwhile reductions in lease operational costs, it being estimated that 26 per cent of the savings would be attained through the centralization of lease facilities, 20 per cent by automatic well production, 18 per cent by automatic tank switching and filling, 18 per cent resulting from automatic custody transfer of crude oil, and 18 per cent by automatic well testing and data recording. This would not only increase the productivity of each lease switcher, but would benefit the pipe line gager as well. This design changed a number of conventional operating practices in order to reduce the cost of the fully automatic lease installation. Some of these changes were: (1) A single, centrally located tank battery to serve up to 640 acres or more, (2) well chokes located at the central tank-battery well manifold, (3) wells controlled at the battery manifold, and (4) only one tank per lease to be used for metering oil into the pipe line with a surge tank to provide additional storage facilities.

Operational functions performed. The lease controls were designed to perform the following operations automatically, which, where applicable, had previously been done manually:

1. Flow each well on a predetermined time schedule with intermitting during flow period if desirable.

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2. Shut in wells at the wellhead in the event of a parted flow line.
3. Test each well once each month or more often if desired and record well number, length of test period, length of flow period(s), unit volumes of produced fluid, water and gas—all on a single chart.
4. Route oil from well through battery, including testing and treating facilities, and into the pipe line.
5. Meter predetermined gross volumes of fluid to the pipe line by means of a metering tank.
6. Measure and record physical properties of the fluid (temperature, gravity, and BS&W) prior to delivery to the pipe line.
7. Prevent "bad oil" (1 per cent or more BS&W) from entering metering tank by continuous monitoring during filling cycle.
8. Prevent the build-up of tank "bottoms" by removing bottoms once each filling-running cycle of the metering tank.
9. Recover the merchantable oil from tank "bottoms" by circulating through the treating system.
10. Shut in the lease after predetermined number of tanks have been run to the pipe line to prevent overproducing daily and monthly schedule-allowable.
11. Prevent loss of oil as a result of malfunction of equipment by shutting in wells.
12. Shut in wells in event of electric or pneumatic power failure.

Construction of the first lease embodying the foregoing features was begun several years ago. Nineteen automatic installations serving 20 leases, on which are located 197 San Andres wells, are now in automatic operation in the Wasson field, but properties-measuring and recording instruments have been installed on only 1 lease inasmuch as this phase is still experimental; and automatic custody transfer has not as yet been finally accepted. An additional 5 leases are under construction with 4 more lease installations planned for the latter part of 1956 to complete this field-wide program. Upon completion of the program, the number of tank batteries serving the 29 leases and 247 wells will have been reduced from 62 to 28, and the run on metering tanks will have been reduced from 171 to 28, or 83.6 per cent.

Automatic Lease Facilities

Fig. 1 shows a typical layout of a lease that produces both clean and dirty oil. Leases that produce only clean oil are similarly equipped, with the exception of the gun barrel or treating tank and the dirty oil separator, which are not required. Equipment numbers circled in Fig. 1 correspond to those shown in parenthesis in the following operations description.

FIG. 4. **Header design for initial** automatic lease installation. It required two high-pressure valves per well.

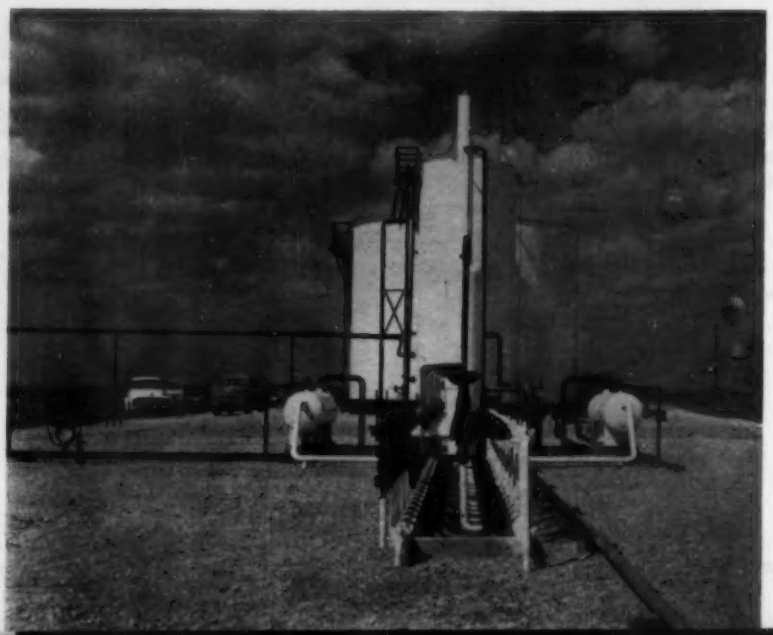
Heart of an automatic lease in the Wasson field is the control house where an electro-pneumatic control system is located. It consists of electrical timers, relays, and solenoids operating pneumatic control valves. Fig. 2 shows the master lease controller which is the electrical brain that controls various functions of the automatic lease-tank battery.

Lease controls are designed to flow or pump each well according to a preset schedule, both as to time of day and days of week. Each well is provided with a separate 24-hr time clock, shown in Fig. 3, which may be set to produce the well either intermittently or continuously for periods from 15 min to 24 hr. A skip-a-day feature permits the well to be shut in one or more days each week. Special timers are provided where intermitter frequency is less than 15 min.

A pneumatic motor valve (4 or 6) with an electric solenoid pilot actuated by means of the time clock is located in each flow line where it enters the wellheader manifold at the tank batteries. The well choke (3) to control flow rate is also located at the header manifold. Fig. 4, 5, and 6 show the three header designs that have been used. Fig. 4 shows the header design used on the original installation. It utilized two separate high-pressure valves to shut in the flow lines and divert flow from the normal production manifold into the test manifold.

In the later automatic lease installations shown in Fig. 5, a single high-pressure valve was used to shut in the well flow and a low-pressure, three-way valve to divert the flow into production or test manifolds. The most recent and most economical design is shown in Fig. 6, where a specially designed high-

FIG. 5. **Header design for intermediate** automatic lease installation. One high-pressure and one low-pressure, three-way valves are required per well.



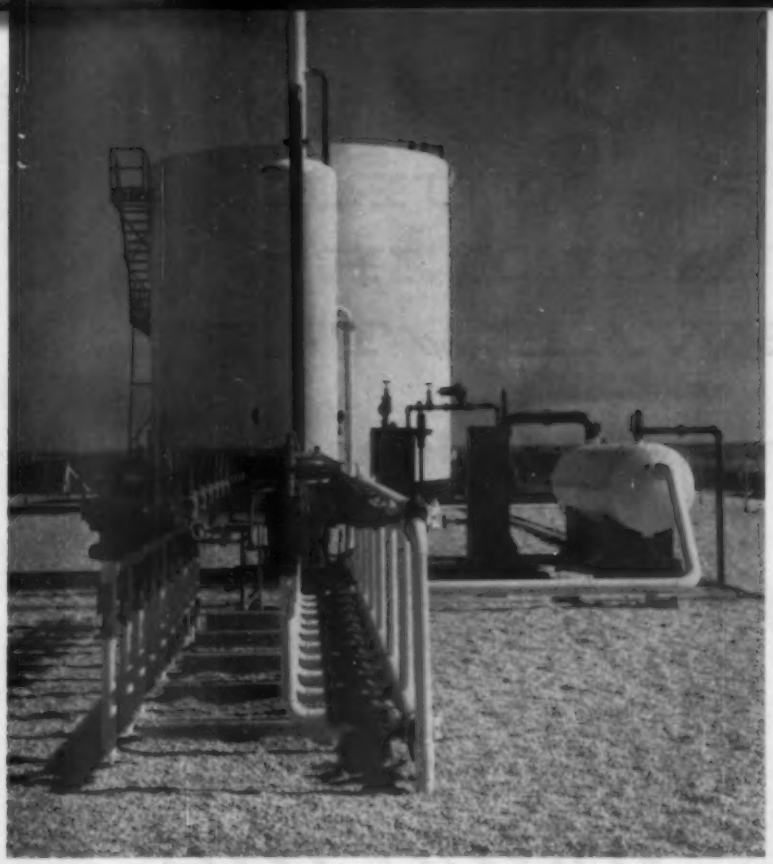


FIG. 6. **Final header design** automatic lease installation. One specially-designed three-way, three-position valve was required per well.

pressure, three-way, three-position valve not only diverts flow into the proper manifold but also shuts in the well.

Full shut-in and flowing pressures are carried in the flow lines from the wellhead up to the lease manifold. A safety valve (2) located at the wellhead shuts in the well should the flow line rupture or be accidentally parted. On 12 of the 19 leases now in operation, these safety valves shown in Fig. 7 and 8 depended upon low pressure to cause the well to be shut in. This method did not prove entirely satisfactory because a number of wells, on being opened up, had pressure drops below the normal minimum flowing pressure. This caused the wells to be shut in, and in some cases killed a well, which then required swabbing to "kick off."

On the 7 most recently completed leases, as well as the leases now under construction, the safety valve shown in Fig. 9 is actuated by differential pressure only, which is a function of flow. Only a 3-psi differential is necessary to close the valve, which may be adjusted over a wide range of flowing conditions. The valve remains closed until the difficulty that caused it to close is corrected and it is manually reset.

Automatic well testing is also incorporated into the lease design. Fig. 3 shows a control panel that controls the well flow and test periods of 4 individual wells. A manually set timer is used to govern the length of well test. Under normal conditions, each well is tested in sequence over a 24-hr period at the same producing conditions (choke size, flowing schedule, intermitter frequency, etc.) as in normal production. The test results are recorded on a strip chart to determine the total fluid, total gas, and total water produced during a given test. Special tests are possible by means of a selector switch for automatic or manual operations.

The normal well production is automatically routed from the wellheader manifold through one of two horizontal separators (7 or 9), depending upon whether the well produces water or clean oil, all of which is shown in Fig. 10. The metering (8) used for automatically testing individual wells is the vertical vessel in the center. On leases where the wells produce only clean oil, or on leases where all wells produce oil-containing water, only one horizontal separator is used. Fluid discharge from the metering separator is commingled automatically with that from either of the horizontal separators, depending upon whether the well on test produces clean or "dirty" oil.

In a typical automatic tank battery for a lease producing both clean and dirty oil, the dirty oil is routed through a slender tank (10) that serves as a heated gun-barrel or settling tank. This is used for dehydrating the wet or dirty production and rerouted tank bottoms. Steam coils (16) in the tank and an external, low-pressure gas-fired steam generator (19) are used to provide the necessary heat for treating the oil-water emulsion.

The battery has a surge tank (11), which is necessary to permit continued production while the metering tank is being run to the pipe line or is temporarily out of service. The clean crude from the gun-barrel flows by gravity into the surge tank, whereas oil from wells producing no water is produced directly into the surge tank, by-passing the gun-barrel.

The third tank (12) in the battery is the one used for metering lease production to the pipe line. The size of

FIG. 7. **Wellhead safety valve** with high-low pressure controller.

FIG. 8. **Wellhead safety valve** with low-pressure controller.

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After the Retrievable Bridge Plug has been run to the desired depth and released, it will automatically set and pack off against pressure differentials established from either above or below the tool.

CAN BE RUN IN AND RETRIEVED EASILY... OR MOVED AND RESET AS MANY TIMES AS REQUIRED

The number of times that the Retrievable Bridge Plug can be released, moved and reset is limited only by the number of operations in the well that require its use.

NUMEROUS ECONOMICAL APPLICATIONS

Used WITH the Baker Full-Bore Retrievable Cementer for:

(a) *Straddle Operations*
The distance to be straddled is not limited by the made-up length of tool.

(b) *MULTIPLE Zone or Selective Testing, Fracturing, Acidizing*

Used BY ITSELF for:

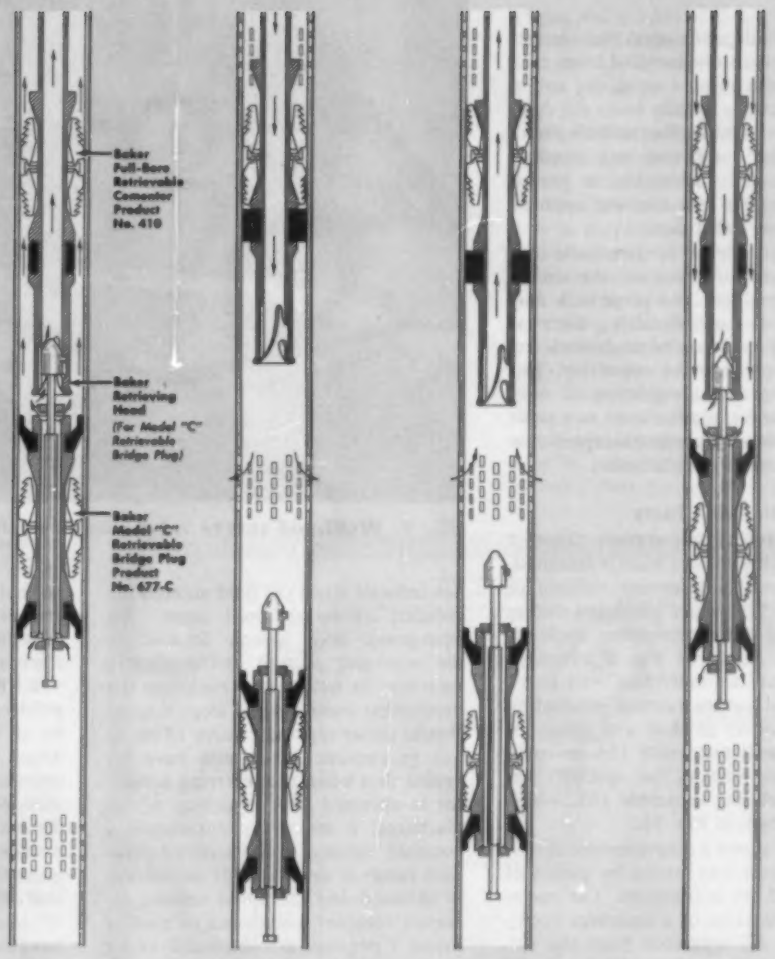
(a) "Down-the-casing" Fracturing or Acidizing

(b) Testing operations

(c) Temporary pressure containment to permit repair to or removal of well head equipment with safety.

Write for Catalog Supplement No. 319 for complete information on

TYPICAL OPERATION


Baker Full-Bore Retrievable Cementer Product No. 410
Baker Retrieving Head (For Model "C" Retrievable Bridge Plug)
Baker Model "C" Retrievable Bridge Plug Product No. 677-C

RUNNING-IN
Retrievable Bridge Plug being run into well on bottom of Full-Bore Cementer through use of Retrieving Head. Note fluid by-pass.

FRACTURING OR ACIDIZING
Plug should be pressure tested after release. Cementer is released, raised above perforations and reset for pressure operations.

SWABBING, TESTING
Note how the reversal of pressure differential has transferred load from one set of slips to the other (both cementer and plug).

RETRIEVING
Plug and Cementer being moved to next set of perforations—or retrieved from well. Valves in plug open to permit fluid by-pass.

Product No. 410

BAKER FULL-BORE RETRIEVABLE CEMENTER

HOLDS PRESSURE FROM EITHER ABOVE OR BELOW

Two sets of opposed slips enable the cementer to hold pressure from either above or below. Casing can be tested before squeeze—and the tubing also, if the Baker Full-Bore Tubing Tester is used.

FULL BORE CONSTRUCTION

Permits Passage of Tubing Perforators or Instruments—Assists in Preventing "Screen-Out" on Fracturing Jobs

The Full Bore through the Cementer (and Tester if used) is in reality a continuation of the bore through the tubing.

This continuous full ID passage not only permits passage of tubing perforators or instruments but assists in preventing "Screen-Out" (sand dropping out of the oil) and subsequent plugging of the tubing in fracturing jobs.

IDEAL STRADDLE TOOL WHEN USED WITH BAKER RETRIEVABLE BRIDGE PLUG

The operation of the Cementer setting mechanism makes it easy (through the use of the Retrievable Bridge Plug Retrieving Head) to release and pick-up the Baker Retrievable Bridge Plug. It is in fact the ideal partner to the Retrievable Bridge Plug for selective multiple-zone or single-zone operations.

these products and their application

BAKER OIL TOOLS, INC.
HOUSTON • LOS ANGELES • NEW YORK

these tanks depends upon the amount of production to be handled from each lease. At the present time, the surge-tank capacity is usually twice the daily allowable, whereas the metering-tank capacity is about one and one-half times the daily allowable to permit manual gaging and running approximately every other day.

With the advent of automatic custody transfer of crude oil, the size of the metering tank and surge tank may be reduced considerably, because many tank runs may be made each day rather than one every other day. This will then permit a reduction in automatic lease installation costs to a point comparable with present accepted conventional lease installations.

Automatic Well Tests

1. **Metering separator.** Once a month each well on a lease is automatically tested to determine volume of fluid, gas, and water produced during its normal daily production cycle. A controller shown in Fig. 3 automatically selects an individual well to be tested and causes normal production valve (4 or 6) to close and opens individual well test valve (5) to route production through the specially designed metering separator (8), which is also shown in Fig. 11.

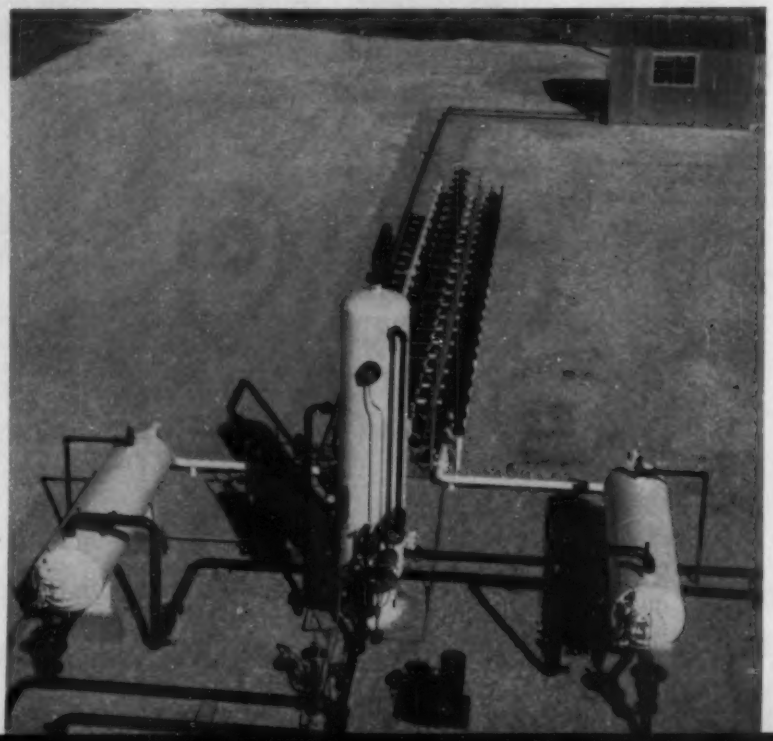
Fig. 12 shows a diagrammatic sketch of the vessel that meters by means of positive 2-bbl increments. The meter is a combination of a separator (compartment A) separated from the volume tank (compartment B) by a solid partition. Fluid enters Section A of the vessel and gravitates into Section B by means of an external line containing a shutoff valve (5), until the top fluid-level is reached. When the level in the metering section reaches the upper float switch, the valve in the line between the upper and lower sections closes and the outlet valve (4) in the line from the metering section to the storage tanks opens. The fluid flows rapidly from Section B until the fluid level reaches the point where the cross-sectional area begins to be reduced. The outlet valve is then throttled to an almost closed position. This limits the rate of level change until the level reaches the bottom float switch. When it does, the outlet valve (4) closes completely and the inlet valve (5) opens again, starting a new metering cycle.

As can be seen from Fig. 12, the top and bottom levels of the metering section are controlled at reduced cross-sectional areas to reduce metering errors. The rate of level change at the control points is maintained at or below the rate of change in the full cross-sectional area, which would not be the case if filling and emptying rates were not reduced when the fluid entered the reduced cross-sectional areas. An emergency float switch located in the separator section automatically switches the well on test back into the production manifold and stops the test should either separator valve (4 or 5) fail to operate. Field tests have revealed that when the metering separator is operated with throttling of the discharge, it meters approximately a constant volume over its entire practical range of operation. If an average is obtained and the meter volume assumed constant, accuracies of plus or minus 1 per cent are obtainable under normal field operation. This same degree of accuracy is obtainable without throttling, if the range of throughput rates is narrowed appreciably.

FIG. 9. **Wellhead safety valve** with differential-pressure controller.

2. **Electronic gas-flow meter.** Gas produced by the well on test is metered by an electrically operated gas meter, which automatically continuously integrates and totalizes the gas flow in units of volume corrected to base conditions. Gas volumes are recorded on a strip chart, eliminating the need for manual integration of standard static- and differential-type charts. Four types of electrically operated gas meters have been installed and are undergoing

FIG. 10. **Separator and header layout** for automatic lease installation producing both clean and dirty oil. Vertical vessel is metering separator; horizontal separator, at right, is for dirty oil, and left, for clean oil.



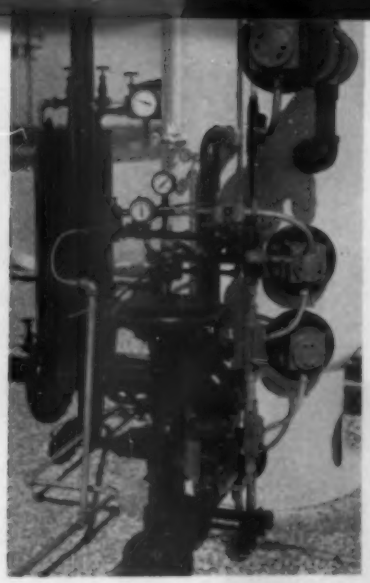


FIG. 11. **Metering separator,** specially designed, with controls for automatic individual well tests.

tests. Two of the meter types under test are shown in Fig. 13, 14 and 15. Fig. 13 shows the bellows-type differential primary element and the electrical transmitter for differential and static-pressure valves. Fig. 14 is a view of the receiver containing the flow-rate recorder, the electro-mechanical integrator, and the totalizer. Fig. 15 shows the most recently developed continuously integrating pressure-compensated flow meter, which is being field tested.

The flow meter shown in Fig. 13 and 14 has undergone an extensive testing and evaluation program with encouraging results. This instrument, as well as the meter shown in Fig. 15, was developed especially for oil-field type of operations where field testing has proved it to be capable of accurately measuring and continuously integrating the fluctuating flows encountered in oil well production.

3. Electronic Water-cut instrument. The electronic water-content measuring instrument used for water-cut determination during well testing is similar to that used for monitoring and measuring the BS&W content of the crude oil prior to its delivery into the pipe line. This instrument, however, has a wider span (0 to 75 per cent cut) than the monitoring instrument, which has a span of 0 to 3 per cent cut. This instrument is described later.

4. Multi-pen data recorder. All pertinent well-test data are recorded on a multi-pen operations recorder, which receives electrical impulses from the metering separator, electric gas meter, and electronic water-cut instrument. The single-strip, chart-type recorder used is shown, along with the gas flow-meter receiver in Fig. 14. A sample chart is shown in Fig. 16. The uniform chart speed makes it possible to analyze the test record to determine not only the volume of total fluid, total gas, and total water but also ratios of oil and gas or oil and water for any volume unit during the test. This information is most helpful in controlling gas-oil and water-oil ratios by means of choke sizes and length-of-flood periods. A well-code device causes each well on test to be identified at the start of its test period regardless of the sequence of the well-test program.

Thus, from the sample chart (Fig. 16), it may be determined easily that Well No. 4 was on test starting at 10:00 a.m. The chart is shown only until 3:00 p.m., during which time the well produced 20 bbl of fluid, 18.8 Mcf of gas, and 4.5 bbl of water. Therefore, during the 5-hr interval, 15.5 bbl of oil and 4.5 bbl of water were produced with a gas-oil ratio of 1212.9 to 1.

Tank Battery Operation

Operation of tankage facilities of a typical automatic installation can be explained by referring to Fig. 1. Numbers in parenthesis below refer to circled numbers on the diagram on Fig. 1.

Oil-containing water goes from the wet-oil separator (7) to the gun-barrel or settling tank (10) where the water is removed, and the dehydrated oil enters the flume (14) of the surge tank (11). Clean oil goes from the clean-oil separator (9) to the surge-tank flume where gas liberated as a result of the drop in pressure is removed prior to its entry into the surge tank. The oil

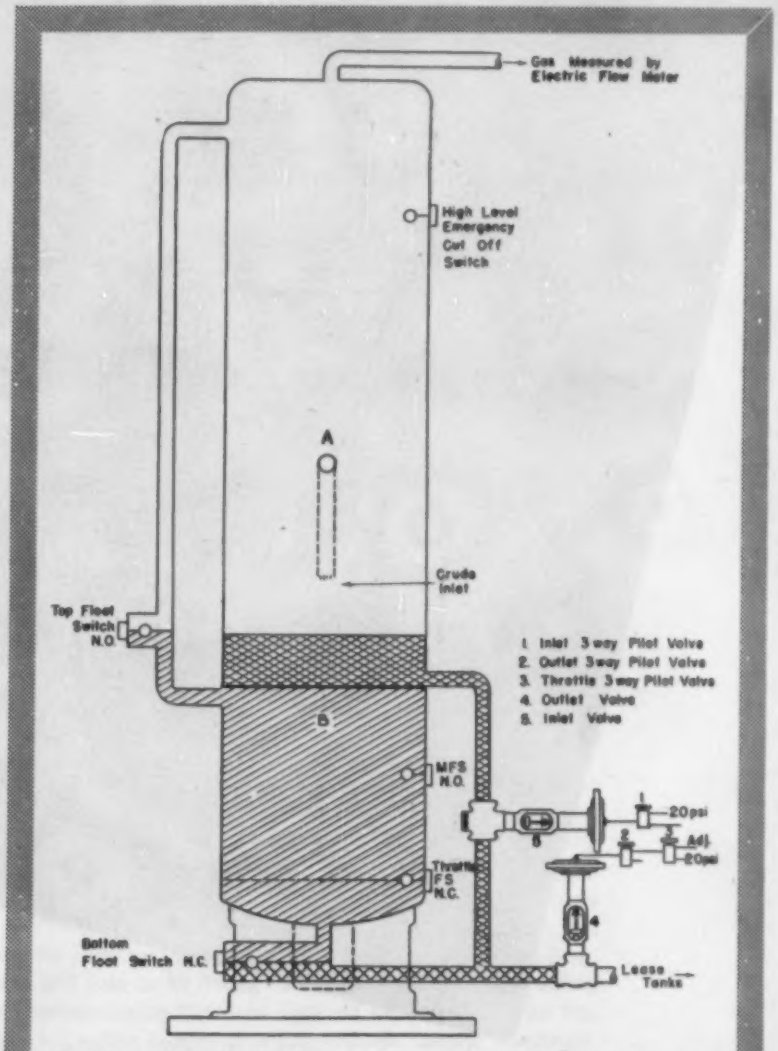
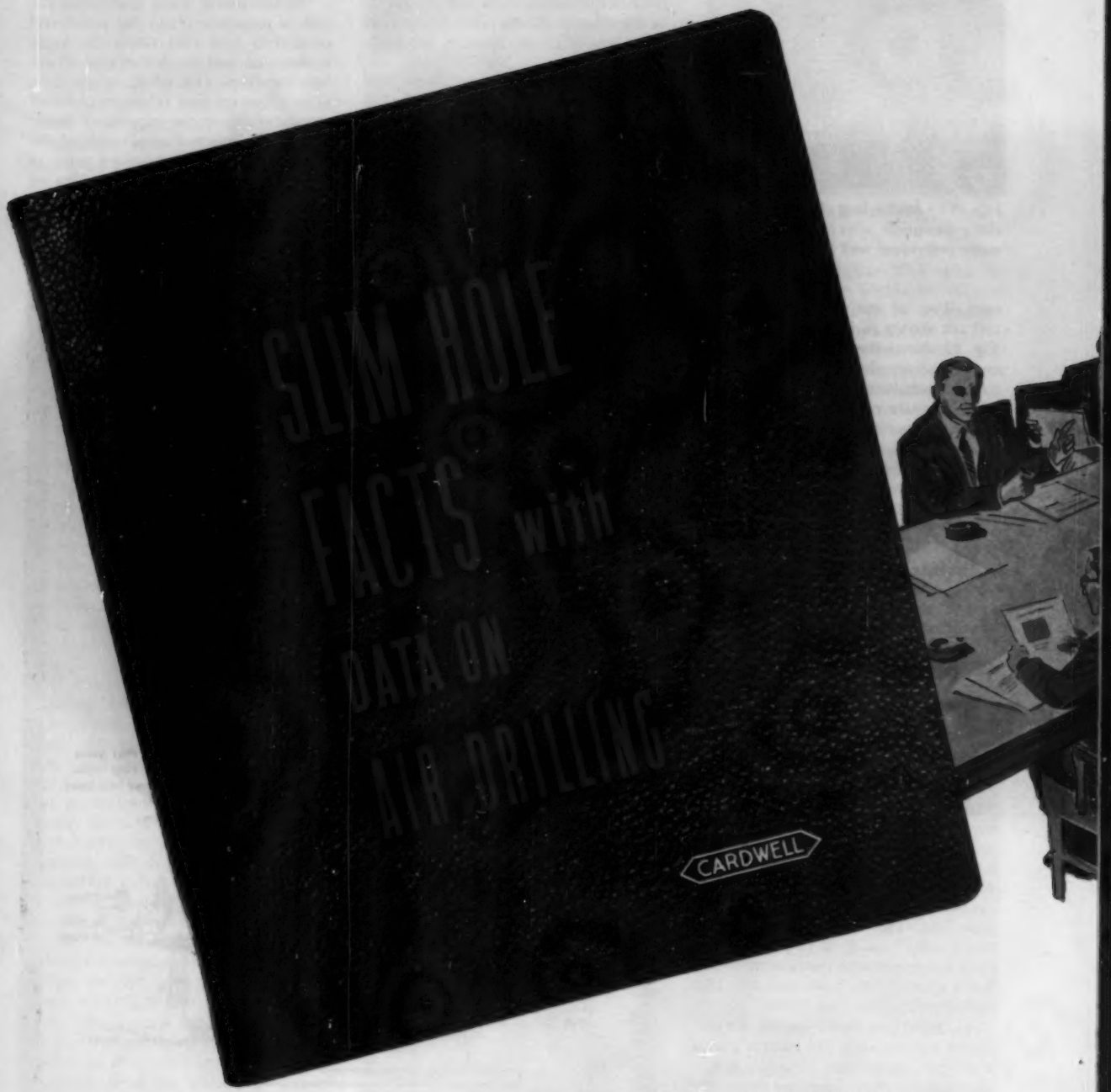


FIG. 12. **Metering separator** shown schematically meters by means of positive two-barrel increments.

the



This 225-page manual covering Economic Considerations, Representative Drilling Programs, Drilling Techniques, Completion Techniques, Equipment Considerations including rigs, pumps, drill pipe, drill bits, and transportation charges, with an entire section on Air Drilling, is available free to contractors and oil company executives upon written request on their company letterhead.

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Today... the industry is faced with an ever increasing demand for oil, and with greater difficulties in finding new reserves. As a result, wildcatting must continue at a high rate to maintain U. S. reserves at a safe level.

High well costs for both wildcat and development wells threaten to choke the economic incentive needed to drill new wells unless something is done. For this reason, many leading producers are looking toward Slim Hole and air drilling as attractive ways to reduce costs. They are considering Slim Hole as an exploration and development tool. Where applicable, substantial savings have already been made.

Recognizing the importance of this trend, Cardwell has prepared this book, "Slim Hole Facts with Data on Air Drilling" as an aid to producers and drilling contractors who are considering these two important techniques. For your free copy, write Philip McLaughlin, Director of Drilling Research, Cardwell Manufacturing Company, on your company letterhead.

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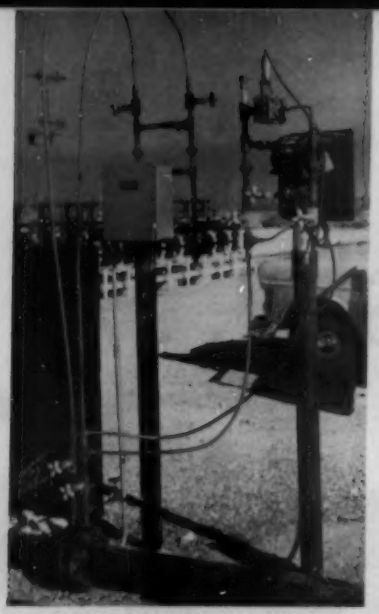

FIG. 13. **Bellows-type differential** and electrical transmitters of differential and static pressures used with continuously integrating pressure-compensated gas-flow meter for individual well testing.

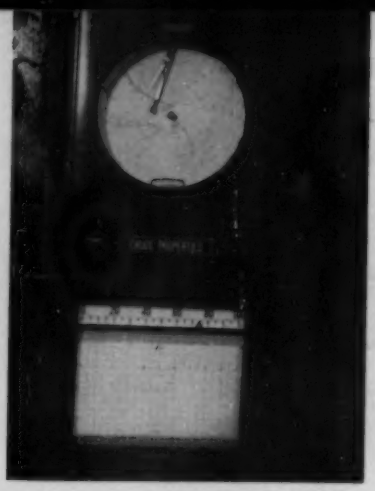

FIG. 14. **Electronic continuously integrating,** pressure-compensated gas-flow meter and multi-pen data recorder used for individual well testing.

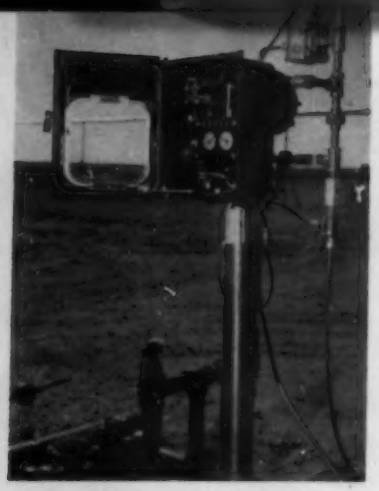

FIG. 15. **Electro-mechanical** continuously integrating, pressure-compensated gas-flow meter used for individual well testing.

enters the surge tank through a spreader (8) below the normal low level to reduce disturbance of bottoms in the tank and to permit some settling out of BS&W from the "clean" oil. An electric-driven pump (15) is used to transfer oil from the surge tank (11) to the metering tank (12). Float switches (33) in the surge tank cause the transfer pump to start and stop in order to maintain the level in the surge tank between normal limits, as shown on the sketch, while the metering tank (12) is being filled. An electronic instrument (37) used for measuring BS&W content of the oil is located on the discharge side of the transfer pump and monitors all oil transferred. Should the BS&W content of oil being pumped into the metering tank (12) exceed a present amount, the inlet valve (21) to the run tank is closed and a by-pass line valve (23) opened so that the oil is pumped back through the treating system. When the BS&W content drops below the preset amount, oil is again pumped into the metering tank. In the event that the BS&W content remains high, the circulation continues through the treating system; and if not corrected, the surge tank (11) will become full, actuating an emergency float switch (34), which causes all wells on the lease to be shut in.

When the metering tank fills to a predetermined level, upper float switch (32) is actuated, stopping the filling cycle and starting a timer, permitting the desired physical properties of the crude to be measured and recorded on

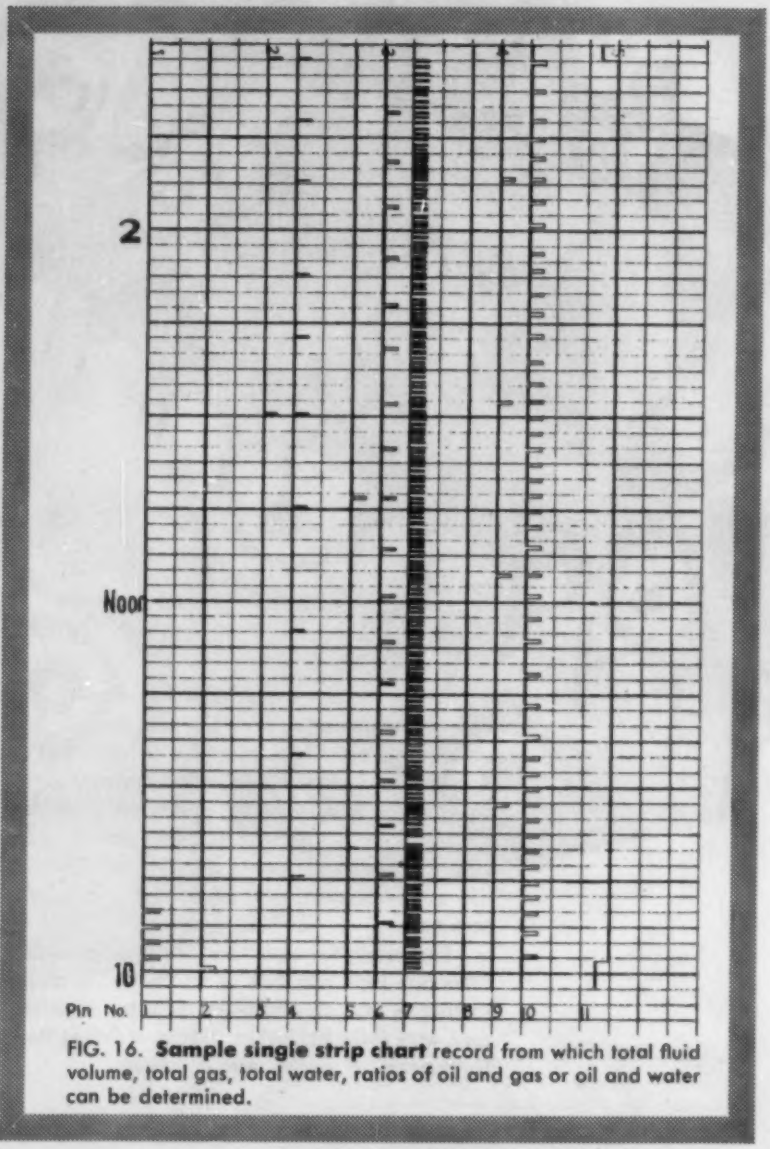

FIG. 16. **Sample single strip chart** record from which total fluid volume, total gas, total water, ratios of oil and gas or oil and water can be determined.

"Customer is well satisfied. Wants two more."

That's the report from a National Supply district manager on this giant wellhead installation—believed to be the world's largest "Christmas tree."

Assembled at our Houston plant, this tree is known officially as a Series 1500 Dual-ported Valve Assembly. It serves one string of tubing set at 11,500 feet with a production packer, and a string open-ended at 9,500 feet. Pleased with its performance in handling 2500 p.s.i. flowing tubing pressure, the customer has already ordered two more of the same size.

Undoubtedly, this is a reliable sample of things to come in wellhead equipment. You'll be seeing more dual completions for new economy, and larger wellhead assemblies to safely handle higher pressures.

In these "things to come," you'll continue to see evidence of National's leadership in the design and manufacture of wellhead equipment. On the next two pages, you'll see some good reasons for this leadership. Whether it's wellhead and other production equipment, drilling machinery or general supply service, we're constantly striving to be fully ready for the needs of operators everywhere. May we serve you soon—at the National Supply Store nearest you?

THE
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You get safe, economical production

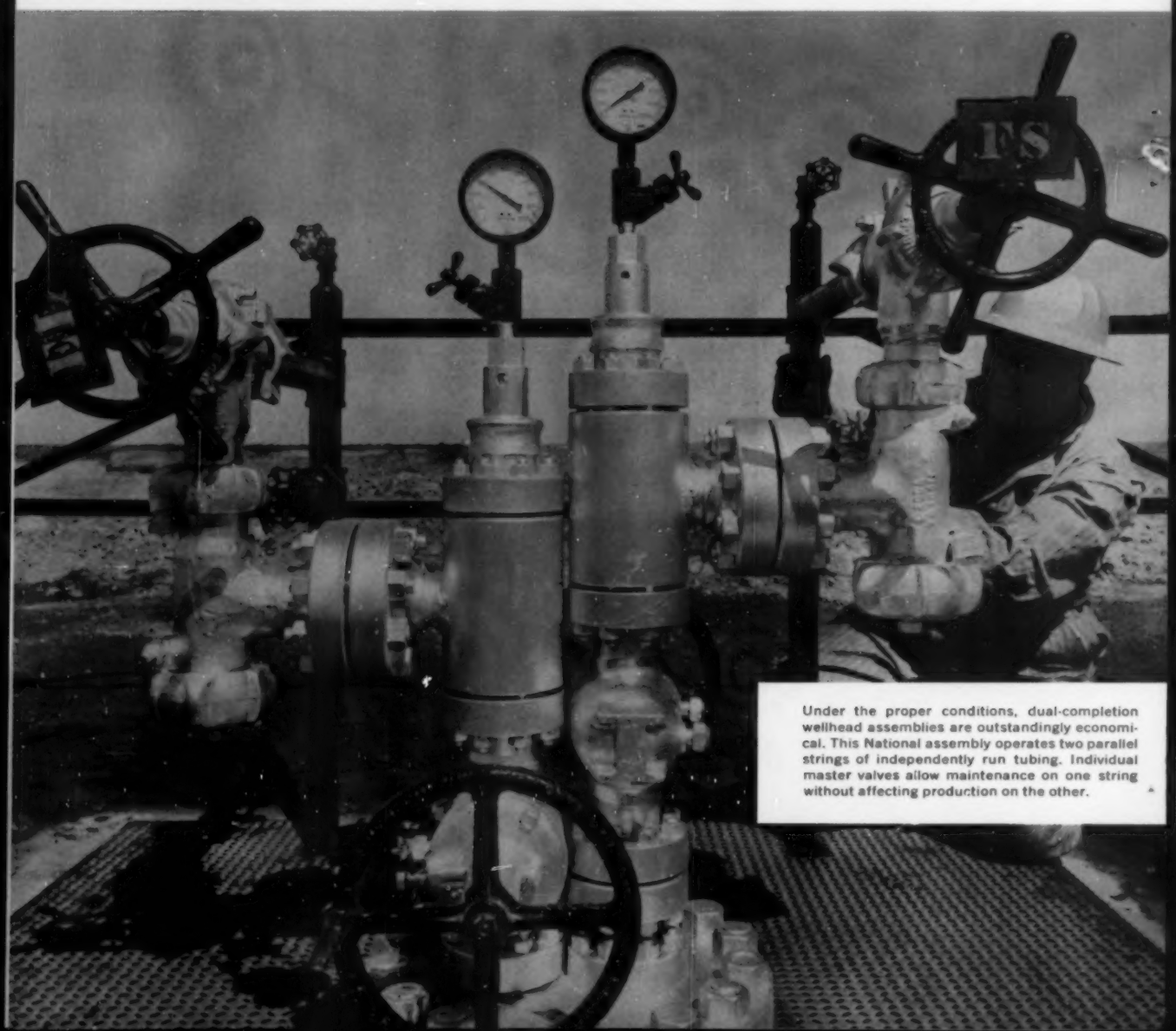
From the bonnet to the casing flange, every component part of a National Wellhead assembly is designed, built and tested for specific service application. The following main features of National Wellhead Equipment insure maximum performance with utmost safety—

Ease of assembly—parts are self-locating and self-activating, no special tools are needed for installation.

Maximum flexibility—interchangeable units afford a multitude of combinations to meet your specific requirements in size, capacity and type.

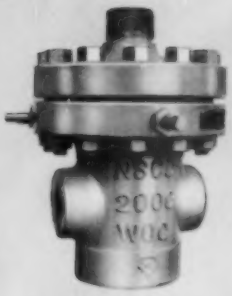
Pre-tested safety—National's triple-sealed Pressure Pack design insures trouble-free performance and longer service life. Intensive testing procedures include special methods more severe than those specified by API standards.

You'll find National Wellhead Equipment readily available through all National Supply Stores—as well as complete advisory service on wellhead application problems. A complete line in every store's stock includes a wide variety of tubing hangers, bonnets, flanged and screwed fittings, valves, flow beans and specialty items to meet your every need. It will pay you to use this quality equipment—and the service that comes with it.

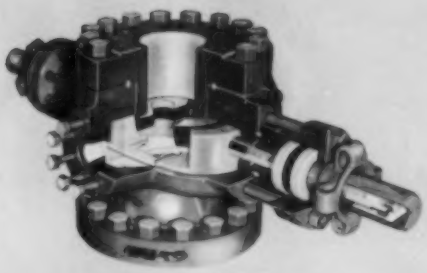


Under the proper conditions, dual-completion wellhead assemblies are outstandingly economical. This National assembly operates two parallel strings of independently run tubing. Individual master valves allow maintenance on one string without affecting production on the other.

with NATIONAL WELLHEAD EQUIPMENT!

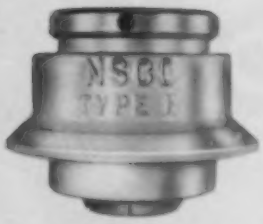


Type W Tubing Head

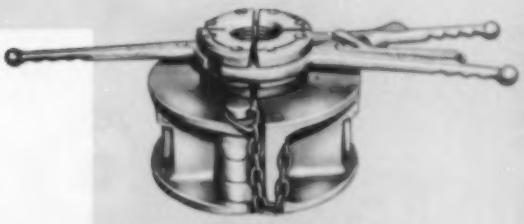


Type C Ram Tubing Head

Type D Casing Head

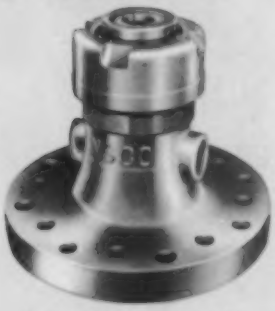


Type H Tubing Support



Type B Tubing Spider & Slips

Every component part is designed for maximum safety, easy assembly and maintenance



Type E Tubing Head with flanged body

Adjustable Choke

Type A Casing Support

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Here's a proven, low-cost system for prolonging production from wells with declining natural energy. Simply designed, easy to install and economical to operate, the Ideal Plunger Lift uses either formation or injected gas to step up recovery in many types of wells. It's especially effective for preventing and removing paraffin deposits, preventing bottom-hole water accumulation and reducing emulsion and scale deposits.

These features of the Ideal Plunger Lift, along with its low initial and service costs, make it a unit that quickly pays for itself. The National Supply representative or store personnel in your area will be glad to tell you more. They have descriptive bulletins and a special Well Analysis form you should see.

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NATIONAL Pumping Units

are manufactured in 22 standard combinations, API rated beam loads from 3,200 to 32,400 lbs.—there's a model to economically suit every pumping job.

NATIONAL Triplex Pumps

provide maximum volume and injection pressures for today's waterflood projects. Available in several hp ratings for both corrosive and non-corrosive service, these National Pumps are especially suited as power-oil source for sub-surface hydraulic pumping, oil gathering and salt water disposal services.

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You get trouble-free service with these precision-manufactured rods. They're engineered for top resistance to shock, corrosion, fatigue and impulse loads. Available in a range of grades for every well condition.

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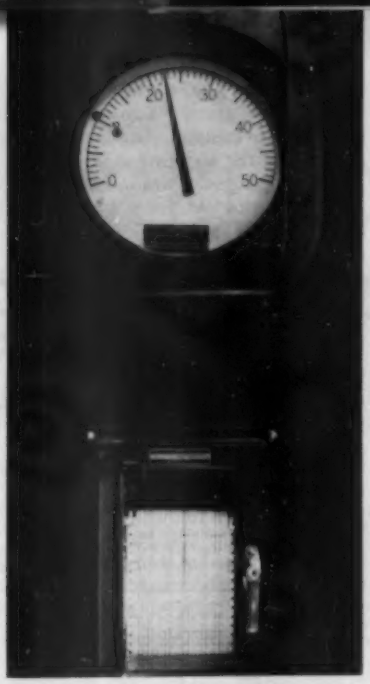


FIG. 17. **Crude properties** recording instruments. BS&W content of crude is measured and controlled by upper unit. Lower instrument records temperature, API gravity and per cent BS&W of crude in metering tank prior to pipe line delivery.

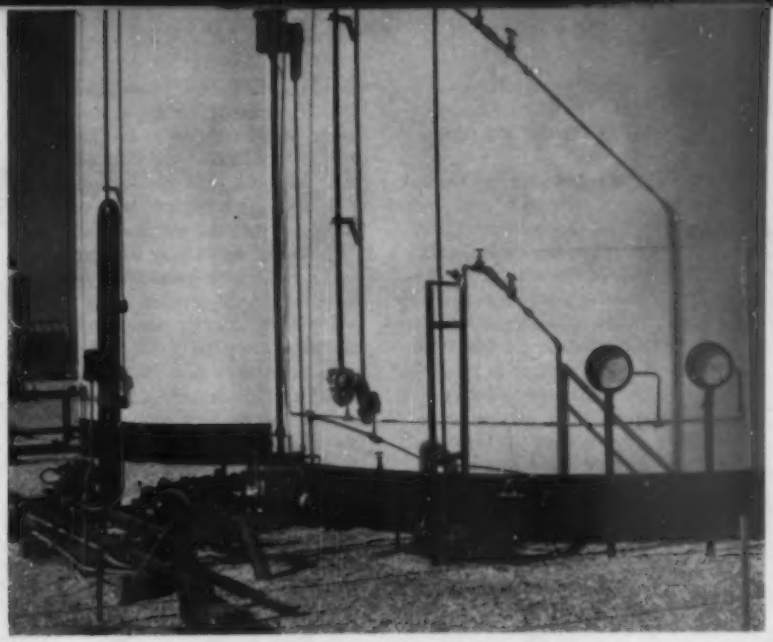


FIG. 18. **Crude oil monitoring system** showing piping, valves, transfer pump, and BS&W monitoring cell (gooseneck piping in center).

a single-strip chart for a preset period of time. A more complete description of these measurement recording instruments (29, 30, and 31) is given later. Fig. 17 shows the recording instrument used for monitoring the BS&W content of the oil as it enters the metering tank and also for measuring the BS&W content of the oil in the tank prior to its delivery to the pipe line. The strip chart is used to record the physical properties of the oil before delivery (temperature, API gravity, and per cent BS&W). While the oil properties are being measured and recorded, "bottoms" from the surge tank (11) are pumped out and circulated through the treating system (10) for a preset length of time.

Upon completion of the measurement and recording of the physical properties of the oil in the metering tank, the valve (20) in the outlet to the pipe line is opened, which, if oil were being run automatically, would run the tank of oil to the pipe line. Because the transfer of the oil custody is still being done manually, a manually operated valve (38) in the outlet is not opened until the tank is gaged and properties measured in the conventional manner. When during running the oil level in the metering tank has been lowered to a predetermined point, lower float switch (32) is actuated, which causes the automatic outlet valve (20) to close. Inasmuch as the transfer of oil custody is still manual, it is necessary that the ending gage be taken manually and the manual valve (38) closed before continuing the metering cycle. As the manual valve is closed, a switch connected to it actuates a timer to give the pipe line gager time to make his ending gage before the metering cycle is continued. Upon completion of the time interval, the "bottoms" in the metering tank (12) are pumped out and through the treating system (10) to reduce the possibility of having "bottoms" build up in this tank, after which oil is pumped from the surge tank into the metering tank to begin another metering cycle.

Should the surge tank become full before the metering tank completes its run, emergency float switch (34) causes all wells on the lease to be shut in until the level in the surge tank is lowered. Likewise, an emergency high-level float switch (25) in the metering tank stops the transfer of oil into the metering tank, should the normal full-level float switch (32) fail to operate.

1. Crude-oil properties measurement. In determining and recording oil properties, the temperature of oil in the metering tank is measured by means of an averaging electrical-resistance element (31) suspended from the deck of the metering tank. The electrical signal, proportional to the temperature of the oil, is fed into a bridge circuit of the properties recorder.

API gravity is measured by means of a float (30) submerged in the oil in the metering tank, and the buoyant force acting on the float, proportional to the density of the oil, is converted into a

FIG. 19. **Metering tank sampling** system for measuring BS&W content of crude oil.

FIG. 20. **Metering tank deck** showing API gravity transmitter (foreground) and electrical-resistance temperature element entrance (back of gravity transmitter).

pneumatic signal, which, in turn, is converted into an electrical signal and fed into a bridge circuit of the properties recorder.

BS&W content is measured by means of an instrument (29) that measures the capacitance of a condenser, with the crude oil acting as the dielectric between the plates of the condenser. Because the dielectric properties of oil and water differ considerably, and knowing the dielectric properties of the particular oil and water, it is possible to translate the capacitance measured by the instrument into percentage of water in the oil. Because the dielectric property of oil is affected by temperature, a temperature-sensing element and a compensating circuit are provided to correct the apparent measurement of capacitance to what it would be at a desired base temperature. The measurement of capacitance is converted into an electrical signal, which is fed to a bridge circuit of the properties recorder.

As shown in Fig. 18, the BS&W content of the oil being transferred into the metering tank is monitored by means of a condenser or capacitance cell inserted into the discharge line of the transfer pump. Should the capacitance of this condenser or probe exceed that corresponding to the desired maximum percentage of water, a switch is actuated by the measuring instrument to close the metering tank fill valve and open a circulating valve to the treating system. The BS&W content of oil in the metering tank is determined by means of a condenser or capacitance cell in a sample line. Three gear pumps (28), operated from the same electric motor, pump samples of oil from three levels (top, middle, and bottom) in the metering tank into the sampling line containing the capacitance cell and then back into the metering tank. One capacitance measuring instrument is used for both the monitoring and sampling cells, with a relay being used to switch from one to the other. Extensive laboratory tests, as well as field tests, have indicated that this instrument is considerably more accurate and consistent in determining percentage of water in oil than the conventional centrifugal method. Laboratory tests have indicated that this instrument is not measurably affected by normal fluctuations in power voltages, salinity of water, aging of electronic equipment (except complete failure), or conductivity of the fluid. The instrument is very easily calibrated by means of standard built-in precision condensers. Adjustment of either the span or zero setting will not affect the other setting. Accuracy of the capacitance measuring instrument alone is 1 per cent of full scale, which is equivalent to 0.03 per cent water. Because of variations of the dielectric properties of the crude oil being measured and errors introduced by the probe and connecting cables, the overall accuracy of the system has proved to be of the order of 1/10 of 1 per cent water. Fig. 18 is a view of the piping, valves, transfer pump, and BS&W cell used to monitor the oil entering the metering tank. Fig. 19 shows the cell used in the metering tank sampling line, while Fig. 20 is a view of the gravity transmitter and temperature element installations on the deck of the metering tank.

The oil properties are recorded on a multiple-record electronic 11-in. strip-chart recorder shown in Fig. 17, which utilizes three separate bridge balancing circuits, one for each of the variables recorded. Each separate record is printed in a different-colored ink and identified by printed numbers with the chart drive being energized only during the properties measurement interval.

2. Automatic custody transfer. Subsequent to the installation of the 12 batteries described previously, discussions were held with a number of men from various pipe line and producing companies, all of whom were interested in automatic custody transfer. These men were asked to suggest what features should be incorporated into any new tank-battery designs so as to make them acceptable for that purpose. Following is a description of 7 tank batteries now in operation as well as new batteries now being installed by Shell on a number of leases in the Wasson field. This revised design includes all features suggested during the previously mentioned discussions among which are:

1. Top and bottom metering levels are to be controlled by spill-over or weir boxes containing float switches to provide a positive means of controlling the levels.

2. The metering tank fill, drain and pipe line outlet lines are to be equipped with valves that are mechanically in-

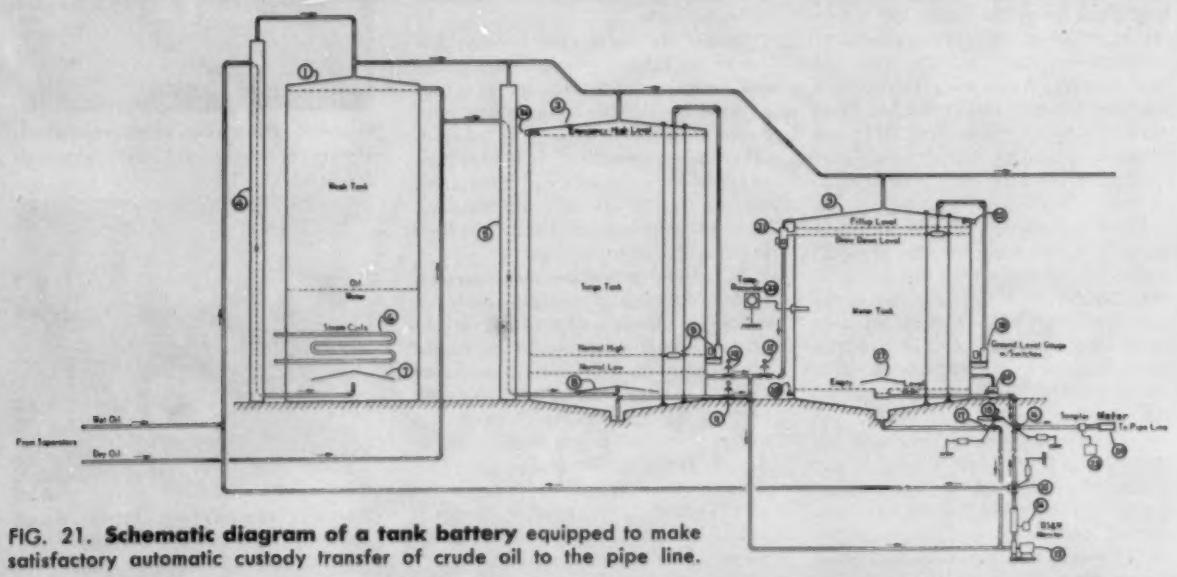


FIG. 21. **Schematic diagram of a tank battery** equipped to make satisfactory automatic custody transfer of crude oil to the pipe line.

AXELSON PICTORIAL

PULSE RATE. A doctor checks heart beat by feeling a patient's pulse. Jerry Caldwell, Pumper for Tidewater Associated Oil Company at Talco, Texas, can tell how his wells are pumping simply by feeling the vibration on the polished rod. Recently, *an Axelson Volu-Max pump with a 1¼" bore x 7 ft. length was installed in this well* (L. D. Wilson #2). It pumps 441 BPD of fluid from 2,900 feet netting 30 barrels of 18 gravity oil. Former rate was 351 BPD and 16 barrels of oil. When your wet wells require greater gross production at the same cycle rate, try an Axelson Volu-Max.

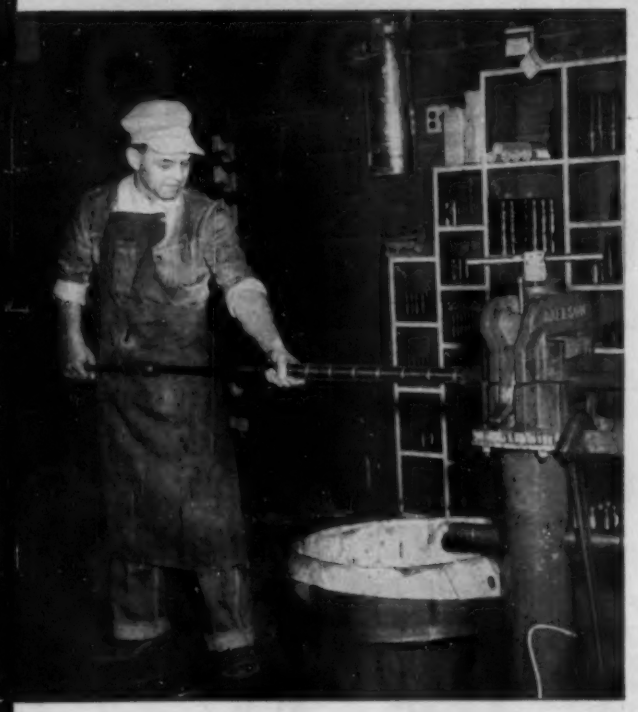
BIRD WATCHER. Jerry Caldwell (see above) raises quail for a hobby. He has over 200 which bring an average price of $2 a bird. He is the empty-handed quail hunter's best friend. Jerry says his birds have one thing in common with Axelson oilwell pumping products—*they don't require much care.*

AXELSON USI

HYDRAX. Here on a stripper well near Kilgore, Texas, is a typical Axelson Hydrax hydraulic pumping unit. Jud Hemperly, Production Foreman for F. A. Fuller Company, is well pleased with the installation — says that *Hydrax units are kind to rod strings.* An Axelson RLA Rod Liner Type Pump, 2 x 1¼ x 9 feet, produces 32 gravity oil from 3,600 feet. Together, the pump and Hydrax pumping unit make an unbeatable combination for low-cost mechanical lift.

AXELSON PICTORIAL

MATERNITY WARD. The Jones & Laughlin repair shop in Oklahoma City is a clinic for ailing pumps and a maternity ward for new ones. Watching the birth of a new Axelson deep-well plunger pump (left to right): O. W. Shepherd, J & L Store Manager; John Rogers, Repairman (see below); Charles Cawthon, Axelson factory representative; and Chet Kyle, Axelson District Manager. Pumps that have been in service for many years are brought back to their original efficiency simply by replacing worn parts, such as liners, plungers, balls and seats, cages and tubes.



ON STILTS. In Grady County, Oklahoma, this Axelson Long Stroke hydraulic pumping unit perches on a unique steel platform to keep it above the water line during flood seasons. It pumps 39 gravity oil from 9,200 feet in Magnolia Petroleum Company's Virgil Daugherty No. 1. The normal length of pumping stroke in an Axelson unit is 25 ft. Pumping rate is 4 to 6½ strokes per minute. *A conventional beam pumping unit with a 6 ft. polished rod travel would have to operate at 25 strokes per minute to match an Axelson 25 ft. polished rod travel at 6 strokes per minute.* By slowing down the pumping rate, Axelson units reduce wear and tear on subsurface pump and rods and cause less turbulence at well bottom.

EXPERT. Making up a new Axelson subsurface pump is John Rogers, Jones & Laughlin pump repairman. *John is reputedly one of the top pump men in the industry.* He was born in Wilburton, Oklahoma, is a graduate of Okmulgee Business College and is a CPA. John also plays a creditable french harp and guitar. He has been with J & L for 12 years, taking excellent care of Axelson pump customers.

MEN OF PRODUCTION. Meet Atlantic Refining Company's well-pulling crew with an excellent safety record and a soft spot in their hearts for Axelson production equipment. (Top) O. A. "Doc" Lambert, Head Well Puller; (Bottom, left to right) B. M. Battles, Gene Larrimore, Hilton Murray. They keep wells producing with Axelson pumps in the Kilgore, Texas, fields.

CAMERA! ACTION! This is Atlantic Refining's well gang in action (see above) stripping the Calvin Young A No. 5 in Rusk County, Texas, to locate a tubing leak. *An Axelson tubing liner pump has been producing this well for many months and went back down the well without requiring service when remedial work was finished.* This area (Longview-Kilgore) is serviced by Dick Baucum and Bill Norman, Axelson Representatives working out of Longview, Texas, and by the Jones & Laughlin supply store in Kilgore.

GOOD WORD. Dusty Dillon (left), District Production Foreman for Atlantic Refining Company in East Texas, looks over well-pulling operation (above) while Doc Lambert lifts another stand of pipe. Like many another production head, Dusty has a good word for Axelson plunger pumps and sucker rods.

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HOT ROD. Slippage in subsurface pumps is frequently caused by wear on the outside surfaces of plungers. To give Axelson plungers long-wearing quality, surfaces are flame-hardened. Mike Sanceri, Axelson Rockwell operator, makes a hardness test on an Axelson plunger to make certain that heat treatment is uniform and to specifications. In spare time, Mike builds hot rods. His latest (a Model A frame and body with a '52 full-race Lincoln engine) took a fourth in its class at Bonnieville doing 164 MPH.

MIKE SIDE. Axelson plungers are made to fit as snugly in pump liners as pistons in a compressor cylinder. *Fits are within .001 inch.* Special API gauges (manufactured by Axelson) are used to check these close tolerances. Axelson also makes chromium plated plungers in a choice of three thicknesses of chromium. (.012, .021, .030 on diameter) for greater resistance to wear. Whatever the well condition—abrasion, corrosion, high water cut, etc. — Axelson plungers withstand the gaff.

NEWEST. Jones & Laughlin employees gather around the new J & L service truck in front of the Lindsay, Oklahoma store, *the newest addition to J & L's network of 91 supply stores in the United States and Canada.* (l. to r.) J. K. Guinn, salesman; L. R. Roberts, district sales manager; B. L. Parker, pump repairman; Bill Woodward, salesman; Karl Modenbach, store man; Dick Bayless, salesman; R. L. Parks, store man; D. H. Saltzman, store manager. Jones & Laughlin is distributor for Axelson production equipment.

No. 3

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FIG. 22. **Metering tank valve system** showing fill and drain lines, plug valves and actuators, and mechanical interlock linkage for automatic custody transfer battery.

terlocked to prevent draining or producing into the tank while "on the line," or running oil to the pipe line while the tank is filling. Seals are to be provided on the interlocks to show evidence of tampering.

3. The temperature of the crude oil will be recorded immediately prior to running.

4. Uniform sample volumes will be taken from each tank run and stored in a pressurized vessel for later tests of composite sample for BS&W content and gravity.

5. Two independent checks on the number of tanks run will be recorded. One will use an electrical counter, while the second will consist of a pressure-gage record of the oil-level changes.

6. Plug valves with automatic pneumatic operators will be used on the metering tank fill, drain, and pipe line outlet lines to reduce the possibility of leakage.

7. Sample cocks will be located around the metering-tank bottom to permit periodic checks on the "bottoms" build-up.

8. Automatic preset electrical counters and adjustable program clocks will provide means for the pipe line receiving the oil to limit the number of tanks run during any time period (day and month) and to schedule running periods during each day as well as week.

9. Electrical controls will be contained in a housing provided with locks as well as seals to prevent tampering with the electrical control circuits.

Fig. 21 shows a diagrammatic sketch of this tank-battery design. The settling tank (1) and surge tank (2) are the same as those described earlier in Fig. 16 except for the use of float-operated ground-level automatic tank gage (9) equipped with auxiliary switches replacing the float switches (33) used to start and stop the transfer pump during metering-tank filling operations.

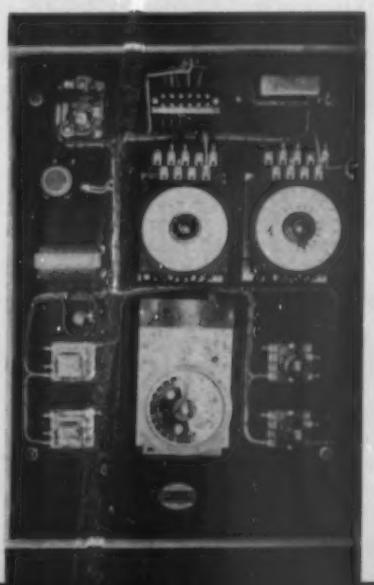
In the operation of this tank-battery design, the metering tank (3) is filled by means of the transfer pump (13) taking suction from the surge tank (2), as in the original design. Immediately downstream from the transfer-pump discharge is located a three-way pneumatically operated plug valve (15) that is positioned to divert flow from the pump back through the treating system (1), except during the metering-tank filling operations. While filling, the flow-diverting valve (15) directs the oil to the metering tank through a line that is connected to another pneumatically operated three-way plug valve (16). This latter three-way valve is positioned to direct the flow either from the pump into the metering tank (3) or from the metering tank into the pipe line connection. Thus the flow cannot be into and out of the tank simultaneously. The electro-pneumatic pilots will cause flow either into or out of the metering tank (3) to cease should there be a failure of either electrical or pneumatic power and will return the valves to their original positions upon return of power.

The metering tank fills through the two three-way valves (15 and 16) and a spreader (27) until a predetermined level is reached, which causes the float-operated, ground-level automatic gage (19) to actuate a switch stopping the pump, shutting the outlet valve (10) from the surge tank, and repositioning the pump discharge diverting valve (15) to close off the line to the tank. The three-way valve (16) at the tank inlet-outlet remains in the fill position. During tests of this design and until there is acceptance of automatic custody transfer, the tank will remain in this position until a manual switch is actuated. An overflow of weir box (21) is located with its fill line located below the normal high filling-level in the metering tank. Upon reaching the high level in the tank (and after the manual switch is actuated), a valve (12) in the drain line from the weir box (21) is opened and the transfer pump (13) started, which draws down the level in the meter tank until the weir level point is reached. Continued pumping causes the level in the weir box to drop until a float switch is actuated, which will stop the pump and close the weir-box drain valve (12).

Because the rate of withdrawal from the weir box is faster than the inflow rate when the head above the weir-box entry is small, a reset timer is started as soon as the weir-box float switch is actuated. Should the level in the weir box rise above the level that actuated the float switch as a result of the continued inflow of fluid, the weir-box drain is reopened and pump restarted to lower the level again. This is continued until the level in the weir box does not rise, after the pump is stopped, for a preset time interval.

Upon completion of the draw-down operation, another timer starts that causes the temperature of the oil in the meter tank (22) to be recorded or, for fully automatic future operations, the physical properties of the oil to be measured and recorded. If desired, a small representative sample may be pumped from the tank into a sample vessel. During this timing interval, the surge-tank drain valve (11) is opened and the "bottoms" from the surge tank are pumped out and through the treating system (1) for removal of BS&W that might have been settled out.

FIG. 23. **Pipe line run** and schedule controller for automatic, custody transfer battery.



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When recording of the temperature or physical properties has been completed, the three-way plug valve (16) in the tank inlet-outlet line is positioned so that the oil can flow from the meter tank into the pipe line connection. A sampler (23), taking periodic samples from the line and regulated by the rate of flow, may be located in the pipe line outlet line. The samples would be stored in a pressurized vessel.

An overflow of weir box (20) is also located in the bottom portion of the metering tank with its top level at the desired lower gaging level. The oil is run to the pipe line through this weir box. When the level in the meter tank is lowered to the overflow level of this lower weir box, further flow to the pipe line causes the level in the weir box to continue to drop until a float switch is actuated, which causes the three-way plug valve (16) to be repositioned to close off the pipe line connection. A reset timer is also started, and should the level in the weir box rise because of continued inflow from the tank, as explained previously, the pipe line connection is reopened to relower the level in the weir box. This operation is continued until there is no increase in the level in the weir box for the preset time desired. Until the tank battery can operate to the pipe line automatically, the metering cycle stops at this point until a manual switch is actuated after manually taking the ending gage.

Upon completion of the pipe line run and actuation of the manual switch, the metering tank drain valve (17) is opened and transfer pump started to pump out the "bottoms" through the treating system. A mechanical linkage (18) shown in Fig. 22 physically prevents the opening of the drain valve when the oil is being run to the pipeline. When the "bottoms" drain-off is completed, the drain valve (17) closes, the outlet valve (10) from the surge tank is opened, and the pump discharge three-way diverting valve (15) is positioned so that the oil is pumped from the surge tank into the metering tank to begin another metering cycle. An independent emergency high-level float switch (25) stops the transfer pump should the level in the metering tank exceed the normal fill-up level.

The number of metering cycles is recorded by means of an electrical counter, shown in Fig. 23 that may be set to limit the number of cycles during the day, week, and month to prevent running more than the lease allowable. A clock-type program timer may be set to restrict the flow of oil to the pipe line to certain hours of the day and also days of the week. A level recorder will be used as a check against the electrical counter for the number of metering cycles run and to insure that full tanks were run each metering cycle. As an additional check on gross volumes of oil run by the metering tank, the pipe line outlet may be equipped with a calibrated positive-displacement meter (24) to record volumes delivered. This meter may be used permanently or only temporarily for checking or proving the metering tank.

Field-wide application feasible. The results attained so far in the Wasson field indicate that large-scale, field-wide application of automatic equipment to oil and gas production operations is entirely feasible. Reduced labor requirements, which have increased operating efficiency on the initial automatic leases, are being effected in accordance with original estimates. Savings and revenue gains, in addition to labor savings, which were theorized initially, are now being realized, contributing considerably to the monetary value of the automatic program. The equipment has proved to be mechanically reliable and efficient although not without a few faults, which can normally be expected in any large-scale development program of this kind. Further installations are, therefore, planned, and by early next year, except for 3 small one-well tracts, all Shell-operated leases in the Wasson field will be equipped for automatic operation.

With the eventual acceptance of automatic custody transfer of crude oil from the producer to the pipe line, it will become possible to take full advantage of increased efficiency of both methods and personnel. Fully automatic oil and gas lease production will then become a reality, permitting the petroleum industry to realize worthwhile savings and increased revenues.

Acknowledgment

The authors wish to express their appreciation to Shell Oil Company for granting permission to present this paper and acknowledge the assistance of R. M. Carter, T. W. G. Richardson, and the Wasson field operating personnel in the development of Wasson field automatic lease project. Without the able assistance and cooperation of the field operating personnel, this program would not have been developed as rapidly or met with the measure of success that it has. Also we wish to thank the many equipment manufacturers and suppliers for their interest in and development of special equipment that will permit even more economical automatic installation to become a reality.

Equipment Description of Typical Automatic Lease Producing Clean and Dirty Oil

1. Control house — contains controls for well production cycles, individual well testing, metering tank controls, transfer pump controls, recorders for temperature, gravity and per cent BS&W content of crude in run tank, and recorders for testing individual wells.
2. Wellhead safety control valve — low pressure or differential-pressure controlled valve.
3. Individual well choke.
4. Individual well manifold valve to route production through treating system — clock-controlled.
5. Individual well manifold valve to route well through automatic well-testing apparatus—clock-controlled.
6. Individual well manifold valve to route production into surge tank directly (clean wells) — clock-controlled.
7. Gas-fluid separator for wells producing water.
8. Metering separator to test individual well production.
9. Gas-fluid separator for wells producing no water.
10. Treating tank to separate BS&W from well production.
11. Surge tank to provide temporary storage while metering tank is "on the line."
12. Metering or run tank—used for gaging crude run to pipe line.
13. Settling-tank flume.
14. Surge-tank flume.
15. Electric-motor driven transfer pump—used to transfer crude.
16. Steam coils in treating tank.
17. Settling-tank spreader.
18. Surge-tank spreader.
19. Steam generator to provide heat for treating system.
20. Automatic metering-tank outlet valve.
21. Automatic metering-tank inlet valve.
22. Automatic metering-tank bottom drain valve.
23. Automatic reroute valve-reroute bleed.
24. Automatic surge-tank bottom drain valve.
25. Automatic surge-tank outlet valve.
26. Automatic routing valves to route well fluid production from test separator to treating system or directly into surge tank depending upon whether well being tested produces water.
27. Automatic steam-control valve to regulate temperature of water bath by controlling amount of steam admitted to coils.
28. Metering-tank crude oil sample pumps.
29. Automatic per cent BS&W-content measuring instrument.
30. Automatic gravity-measuring instrument.
31. Automatic temperature-measuring instrument.
32. Metering-tank fluid-level control float switches.
33. Surge-tank fluid-level control float switches.
34. Surge-tank high fluid-level emergency lease shut-down float switch.
35. Metering-tank high fluid-level emergency pump shut-down float switch.
36. Treating-tank high fluid-level lease shut-down float switch.
37. Automatic BS&W-cut detector for monitoring crude oil.
38. Metering-tank outlet valve — manually operated by pipe line gager under present semi-automatic operation.
39. Electronic gas-flow meter.
40. Pressure regulators — set for approximately 15 psi.
41. Metering-separator high fluid-level emergency float switch.
42. Metering-separator top fluid-level switch.
43. Metering-separator middle-float switch.
44. Metering-separator throttling-float switch.
45. Metering-separator inlet valve.
46. Metering-separator outlet valve.
47. Metering-separator bottom-float switch.

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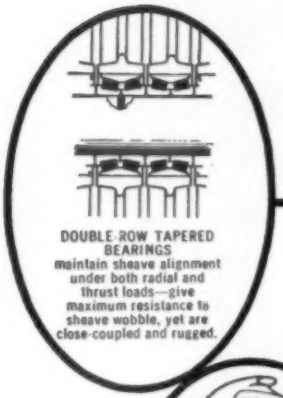

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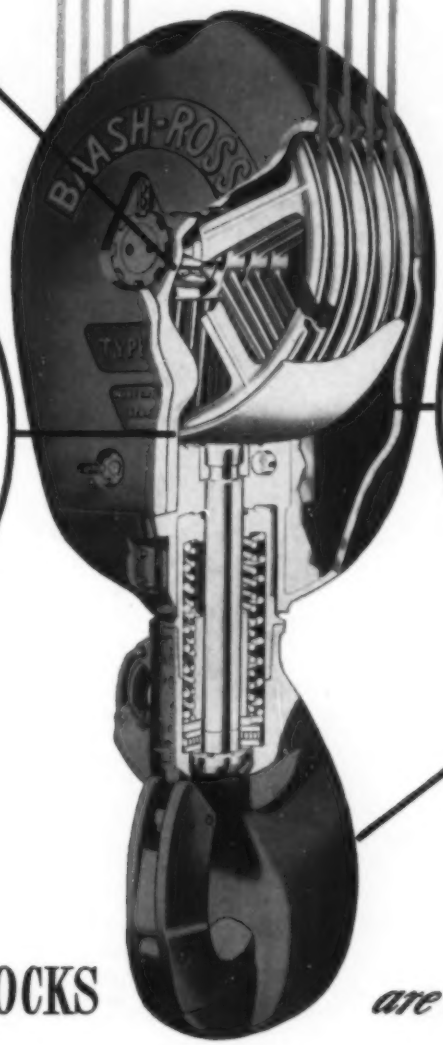

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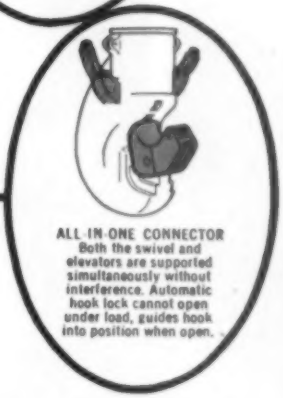

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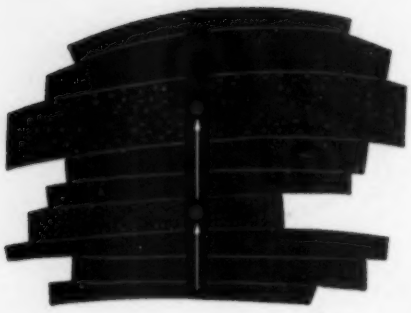

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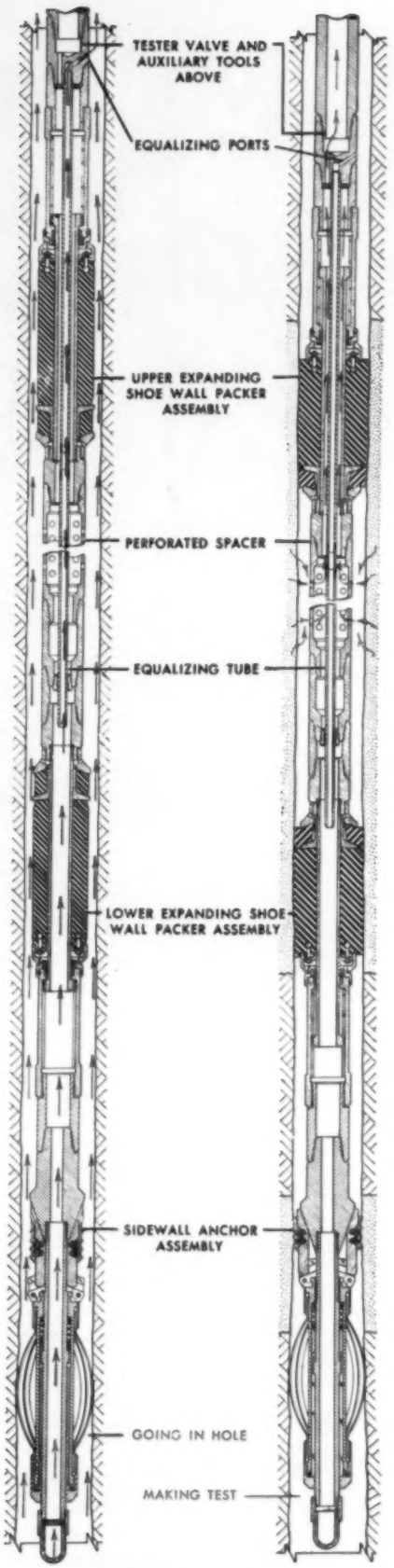

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The Future of Water Flooding in the U.S.

Albert E. Sweeney Jr.
Interstate Oil Compact Commission
Oklahoma City, Oklahoma

TOTAL annual production from water-flood operations in the United States has increased over the past 4 years from 80,000,000 bbl to approximately 130,000,000 bbl. Using the past history of water-flood production, a predicted curve for the future water-flood production has been prepared and is shown in Fig. 1. A maximum peak of water-flood production of 750,000,000 bbl annually is estimated for 1980, and a total water flood-production of 32.5 billion from all water-flood operations is predicted. Most of this future water-flood oil will come from Texas, Louisiana, California, Illinois and Oklahoma.

The increase from 80,000,000 bbl to approximately 130,000,000 bbl represents an increase from about 2.8 per cent of the total production in the United States during 1950 to slightly more than 5 per cent during 1955. This rapid change in the magnitude of water-flood production is of particular interest. This increase is little short of phenomenal.

Purpose of this report is to give some indication of what the future may be. In order to do this, one must study the past history and utilize trends and overall estimates of the total expected production in making sound conclusions regarding the magnitude of future production.

How study was made. Fortunately, in the past few months, a paper in regard to the future of oil production has been presented,[1] in which the authors present methods of estimating the overall total future production of crude oil in the United States together with the results of their computations utilizing such methods.

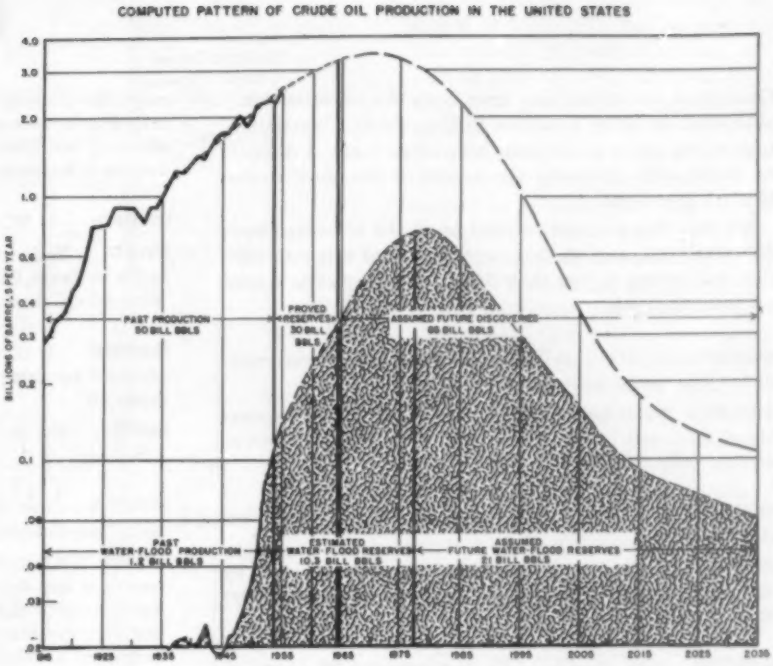

FIG. 1. **Predicted pattern of water-flood production** in the U. S. Data on water-flood production were super-imposed on a curve contained in the report, "Future Growth and Financial Requirements of the World Petroleum Industry," by J. E. Pogue and Kenneth E. Hill of the Chase Manhattan Bank of New York City.

In preparing a pattern of future production, the curve is usually divided into three principal parts. First, the past history — by which certain rules or trends can be ascertained. The second portion of the curve is obtained by the extrapolation of the past history to some future point. This point represents the end of present estimated recoverable reserves, which can be predicted with a reasonable degree of certainty. The final part, which is entirely unpredictable from any rules, must be based upon an assumed value that is within the realm of reason. This is related either to past history or total available area or volume for exploitation.

The first part, or past history, of water flooding had its beginning in the 1920's, although the use of water to increase oil recovery was one of the first methods proposed. J. F. Carll, in 1880 in the Second Geological Survey for the Pennsylvania Topographic and Geologic Survey, suggested that water flood might be beneficial and even suggested a practical method of application. However, only sporadic and, in

LABORATORY ANSWERS PERTINENT QUESTIONS ABOUT NON-FLUORESCENT OIL IN EMULSION DRILLING FLUIDS.

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by Doyne L. Wilson
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QUESTION . . . Can NO-GLO OIL be substituted for Diesel oil to achieve the *same* results?

ANSWER . . . NO-GLO OIL can be substituted, volume for volume, for Diesel oil and the resulting drilling fluid will have virtually the *same* physical characteristics and will be maintained in the *same* manner. In areas where the use of commercial emulsifiers are desirable, the same amount of this emulsifier for either oil will produce equivalent mud properties.

QUESTION . . . What are the objections to using Diesel oil or similar cuts?

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ANSWER . . . No. In all of our experience there is no known difference.

QUESTION . . . Are there any special precautions necessary in using non-fluorescent oil after it arrives at the rig site?

ANSWER . . . All tanks and lines for handling the oil should be free from any fluorescent materials. If this is not convenient, the oil may be directly introduced into the mud stream from the delivery truck or drums. Reasonable care should be exercised to minimize contamination by other oils or rig greases. A non-fluorescent thread lubricant is unnecessary if job is of short duration; however, for drilling jobs lasting over ten days, NO-GLO THREAD LUBRICANT should be used.

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many cases, clandestine floods were in operation until 1921. The method was legalized at that time and soon became a contributing factor in the production from the oil fields of Pennsylvania. Use of water flooding outside the eastern states is a relatively recent innovation.

U. S. water-flood history. Fig. 2 shows the total water-flood history for the United States with each of the states superimposed upon the others as they began to utilize this method. Pennsylvania is the base state with New York, Oklahoma, Kansas, Texas, Illinois, Arkansas, West Virginia, Indiana, Kentucky, and miscellaneous, in that order. Actually, some of the states in the miscellaneous group may possibly have had water floods in operation prior to some of the states that are named; however, their production has not been large and would not show on this figure. Since it is rather difficult to evaluate individually the states other than Pennsylvania from Fig. 2, individual histories of water-flood production in Illinois, Kansas, Oklahoma, and Texas are presented in Fig. 3. The great increase in water-flood production is readily apparent from this figure.

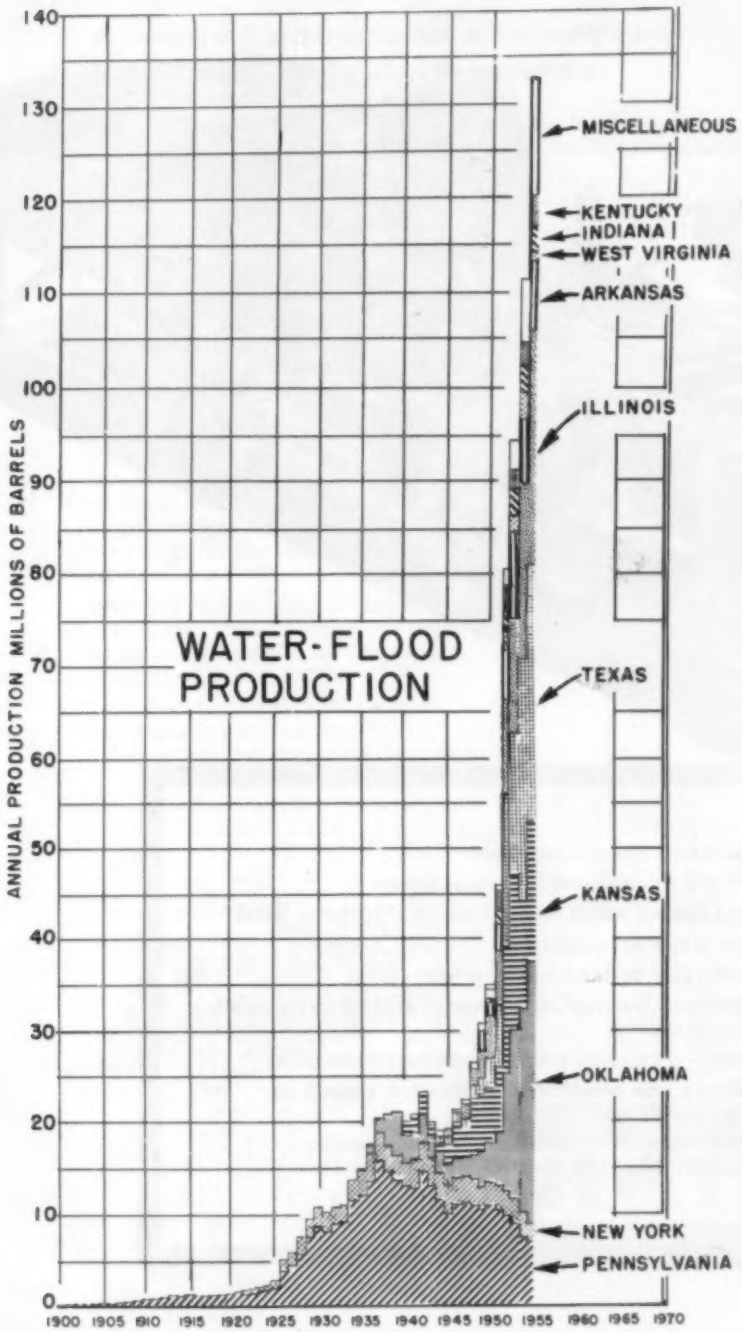

FIG. 2. **Water-flood production** history of the U. S., showing status of various oil-producing states.

Historically, Oklahoma was the first state outside of the eastern Appalachian area to employ water flood as a method of increasing oil recovery. The first project was started during the period of 1932-1933, but no appreciable amount of production was developed prior to 1935. After this date, water-flood production increased fairly rapidly.

Operations were necessarily curtailed during World War II because of the lack of personnel and material. Of course, the depressed price of oil did not encourage development of these projects. Water-flood production increased materially after the war, beginning in 1947. The production was increased substantially in 1951, when this method was initiated in fields outside of the northeast Oklahoma area. Application of water flooding on a field-wide basis has been a large factor in this increase. At present, the water-flood production amounts to nearly 14 per cent of the total crude oil production in Oklahoma.

In Kansas, water flooding was initiated shortly after passage of the law in 1935 legalizing such operations. Production from such operation has increased steadily since that time and is now approximately 12½ per cent of total oil production.

Illinois has had a phenomenal increase in water-flood production. Since 1950, the volume of annual water-flood production has almost tripled. Total production from water floods in Illinois during 1955 has been estimated to have been 30 per cent of the total production.

In Texas, the volume of production from water-flood operations has increased from approximately 4,000,000 bbl in 1950 to almost 30,000,000 bbl in 1955. This 30,000,000 bbl represents only 3 per cent of the total production for the State of Texas. In other states, increases have also occurred so that water-flood production has increased considerably over the past 5 years.

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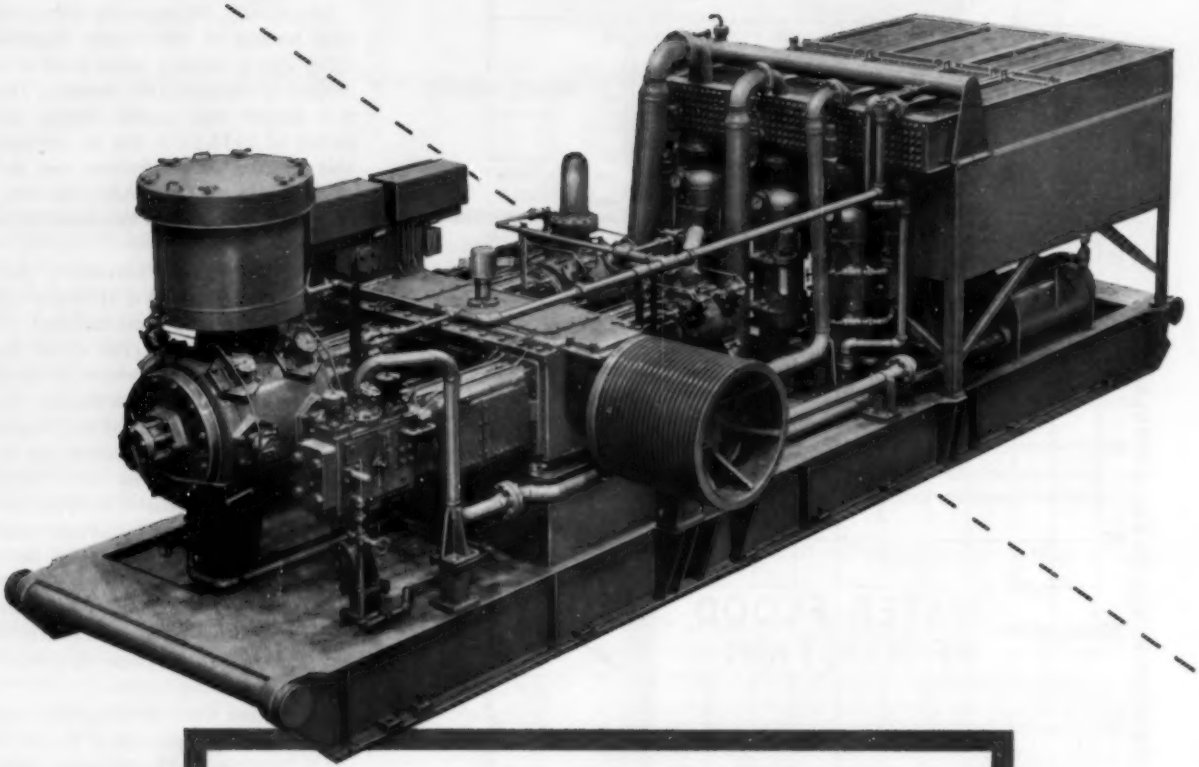

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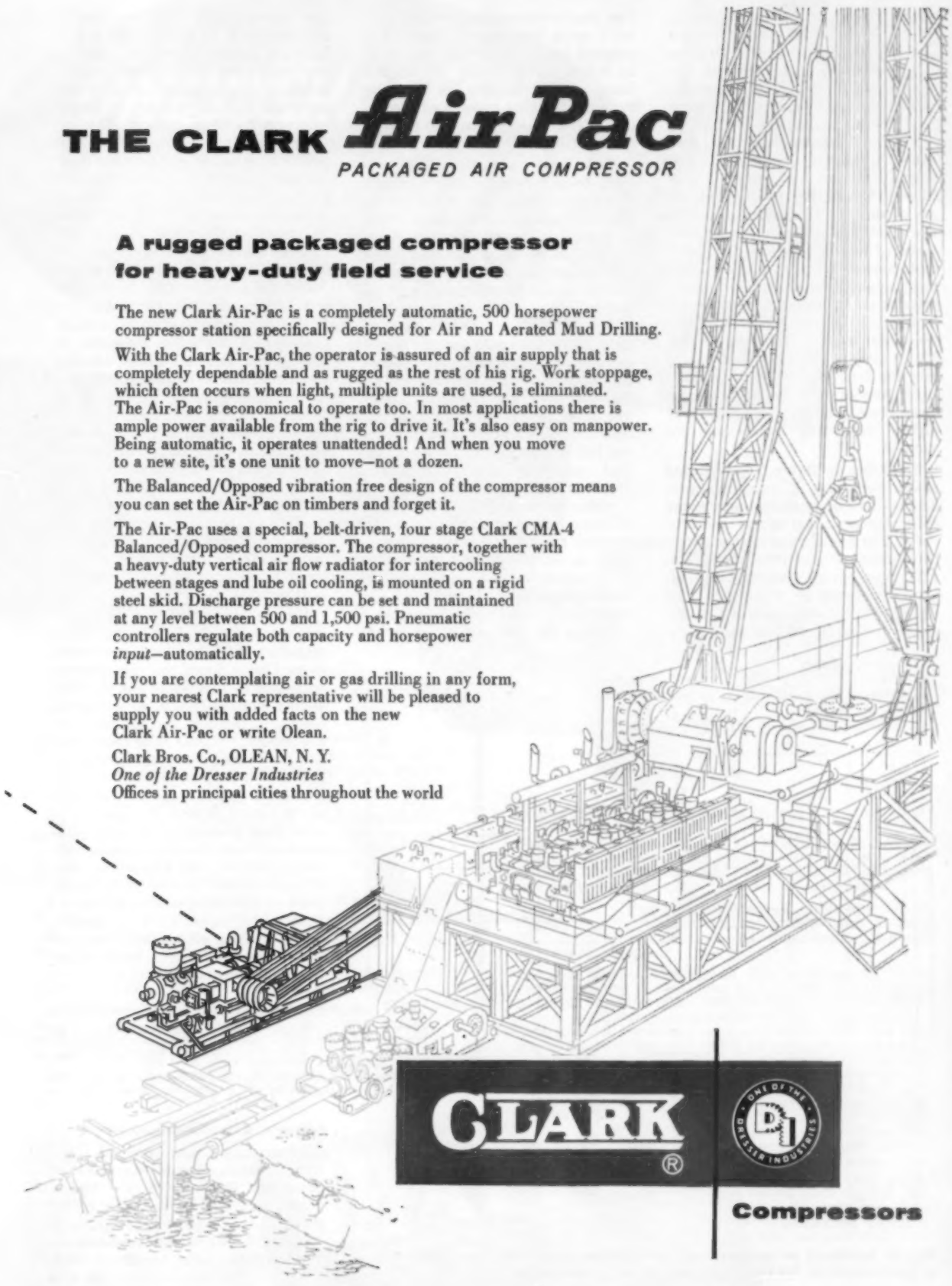

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U. S. Production Pattern. In Fig. 1, the data on water-flood production has been superimposed over Fig. 10 from "Future Growth and Financial Requirements of the World Petroleum Industry," by Pogue and Hill.[1] The upper curve is the "Computed Pattern of Crude Oil Production in the United States" from that publication. This curve is divided into three parts — from 1915 to 1954 of 50 billion barrels past production. The second part of 30 billion bbl proven reserves that at their predicted rate of production, will last approximately 10 years, or, until 1965. The last part is the assumed future discoveries of 85 billion barrels, or approximately an amount equal to that discovered to date. This will be produced using their computed pattern over the following 70 years, or until 2035. At that time, the total production in the United States would be only slightly more than 100,000,000 bbl annually.

Predicting the future. The predicted production history of water-flood production has been divided into three parts similar to that of the reference curve. The first portion of past water-flood production to 1954 amounts to 1.2 billion barrels. Utilizing the estimates presented by Torrey[2] of 11.5 billion barrels, the estimated water-flood reserves are 10.3 billion barrels. This total would not be produced until 1977, using the computed curve. The assumed future water-flood reserves of 21 billion barrels would not be produced until 2035, using this curve. By this time, the total water-flood production would be approximately 60,000,000 bbl annually.

Peak flood production. The peak water-flood production was estimated as an approximate 25 per cent of the total production in the United States at that time. This point was predicted to occur shortly after the total production had reached a peak when new discoveries would be insufficient to maintain the rate of production. If the present growth of water flood is extrapolated, this peak could be achieved as early as 1965. However, a less optimistic rate of increase was assumed so that this peak was reached in 1980. The total annual production at that time from the curve prepared by Pogue and Hill is 3,000,000 bbl. The peak annual water-flood production is then 750,000,000 bbl.

Although the 11.5 billion bbl given in Torrey's paper represented estimated reserves for all fluid-injection operations, an estimate of 29 billion barrels of oil is believed to be recoverable by fluid-injection methods, providing economic conditions become favorable.

Taking this into consideration, the 11.5 billion barrels for water flood is not believed to be too optimistic. The assumed future water-flood reserves are based upon the fact that as additional oil is discovered, some of the fields will have oil that can be recovered only by these methods. This assumed reserve would be reduced materially by the early application of these methods to fields during the primary period of production. However, in many of the areas of the United States, the incentive for application of improved methods of recovery is not sufficient to warrant their use at this time. These fields will become prospective water-flood projects in the future.

The total water-flood production, including past production, estimated reserves, and assumed future reserves totals 32½ billion barrels. This is only slightly more than 20 per cent of the total production estimated by Pogue and Hill. This seems to be a reasonable relationship. The ratio of estimated recovery from fluid injection operations under economic conditions as of 1-1-54 to past production in the data presented by Torrey is approximately 25 per cent while the ratio of the maximum recovery obtainable by application of fluid-injection methods to past production is 61 per cent.

Future water flood areas. After ascertaining a pattern for the future magnitude of water-flood production in the United States, the only question remaining is from where will this production come? This is an extremely speculative question, and depends upon a number of factors. The indications can be obtained from past history, together with the data that has been assembled in regard to the Oil Resources of the United States.[2] The increase in water-flood production will come without doubt from Texas, Louisiana, California, Illinois, and Oklahoma, with perhaps sizeable recovery from almost every oil-producing state in the nation. These states named have the greatest prospects, and will undoubtedly contribute the major portion of the future water-flood production.

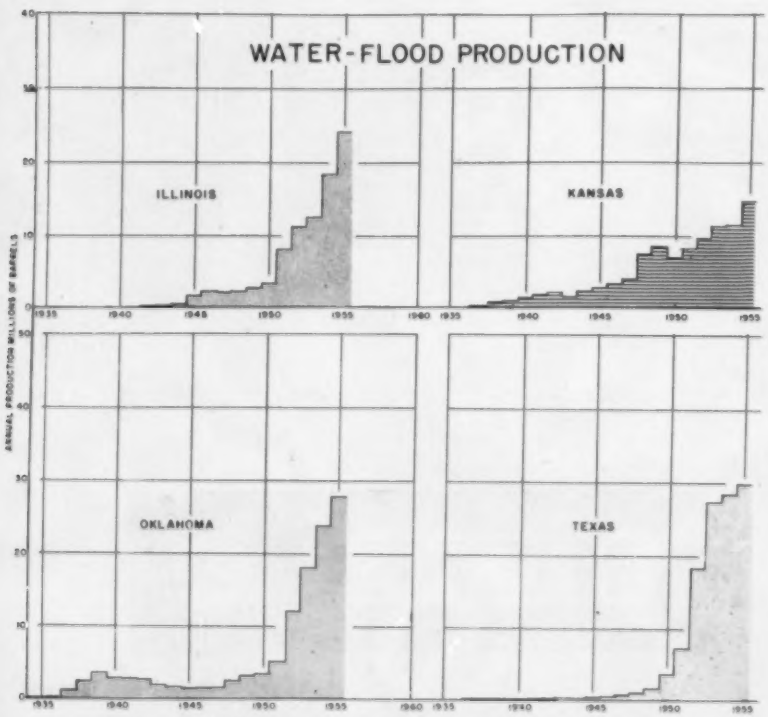

FIG. 3. **Increase in water-flood production** from these four states is quite impressive and indicates the growing trend today.

References

1. Pogue, Joseph E., and Hill, Kenneth E., *Future Growth and Financial Requirements of the World Petroleum Industry*, The Chase Manhattan Bank, New York City.
2. Torrey, Paul D., "Oil Resources of the United States," *The Oil and Gas Compact Bulletin*, Vol. XIV, No. 1, June, 1955.

Editor's Acknowledgment

Material presented above was taken from a paper, "Future Magnitude of Secondary Recovery in the United States," delivered by the author before the 26th Annual Meeting of the North Texas Oil and Gas Association at Wichita Falls, Texas, March 24, 1956.

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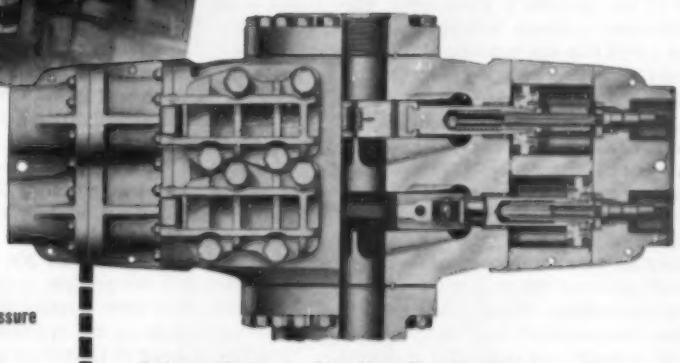

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Oil Recoveries and Profit

Elements of Water Injection

Some factors that govern how much oil is to be recovered and items that influence the profit picture in waterflooding

J. Randolph Buck
McCoy and Buck, Petroleum Consultants, Dallas, Texas

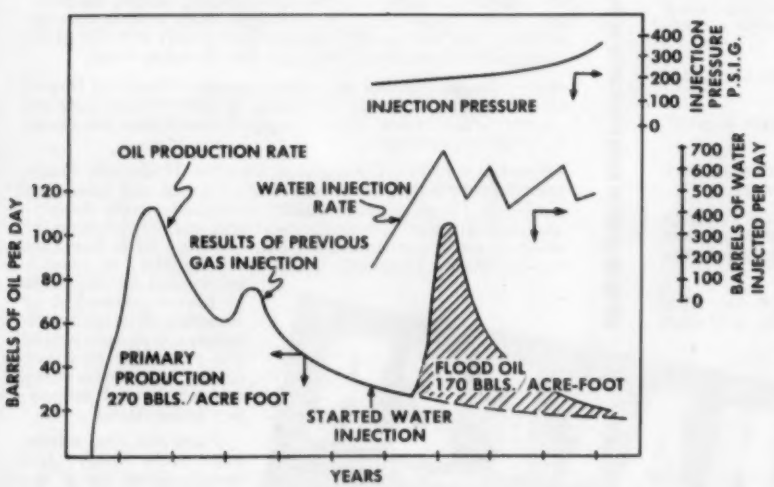
IN the final analysis, the barrels of oil to be recovered by waterflooding is represented by the difference in oil saturation in the sand between starting and terminal conditions. A reduction in oil saturation from 50 per cent of pore space to 35 per cent is exactly the same recovery in barrels as from 30 per cent to 15 per cent for a given sand. This arithmetic indicates how it is possible for a field that has produced a high primary recovery with a lower residual oil at the start of flooding to perform equally as well during flooding as a similar field that produced less on primary and consequently possessed a higher residual oil at the start of flooding. The fact that a field has already produced 3000 to 5000 bbl an acre or more on primary recovery does not by itself condemn the property for secondary operations. Many field cases that have demonstrated high recoveries on both primary and secondary make this a correlation of definite interest. On the other hand, unusually low recoveries on primary make one wonder if the reasons causing it might also apply during flooding.

Typical Recovery Values. Success of flooding is measured from the practical point of view by the investment required to obtain a given production; accordingly, recovery in terms of barrels per acre or per acre-foot is only half the story. The range of expectations, however, does help one to set his sights properly with respect to his own properties. Without going into the extraordinary recoveries occasionally achieved, it can be stated that it is not fantastic to produce as much oil during flooding as was previously produced. Primary recovery by solution gas drive falls in the range of from 150 to 200 bbl an acre-foot. It is not prudent to base anticipated profit from a rather ordinary flood on recoveries this optimistic. Recoveries of some 75 to 100 bbl an acre-foot would normally be considered very satisfactory flooding. At the low end of the scale, a dump flood yielding 10 bbl per acre-foot from a massive limestone section with negligible investment would constitute a highly successful economic venture.

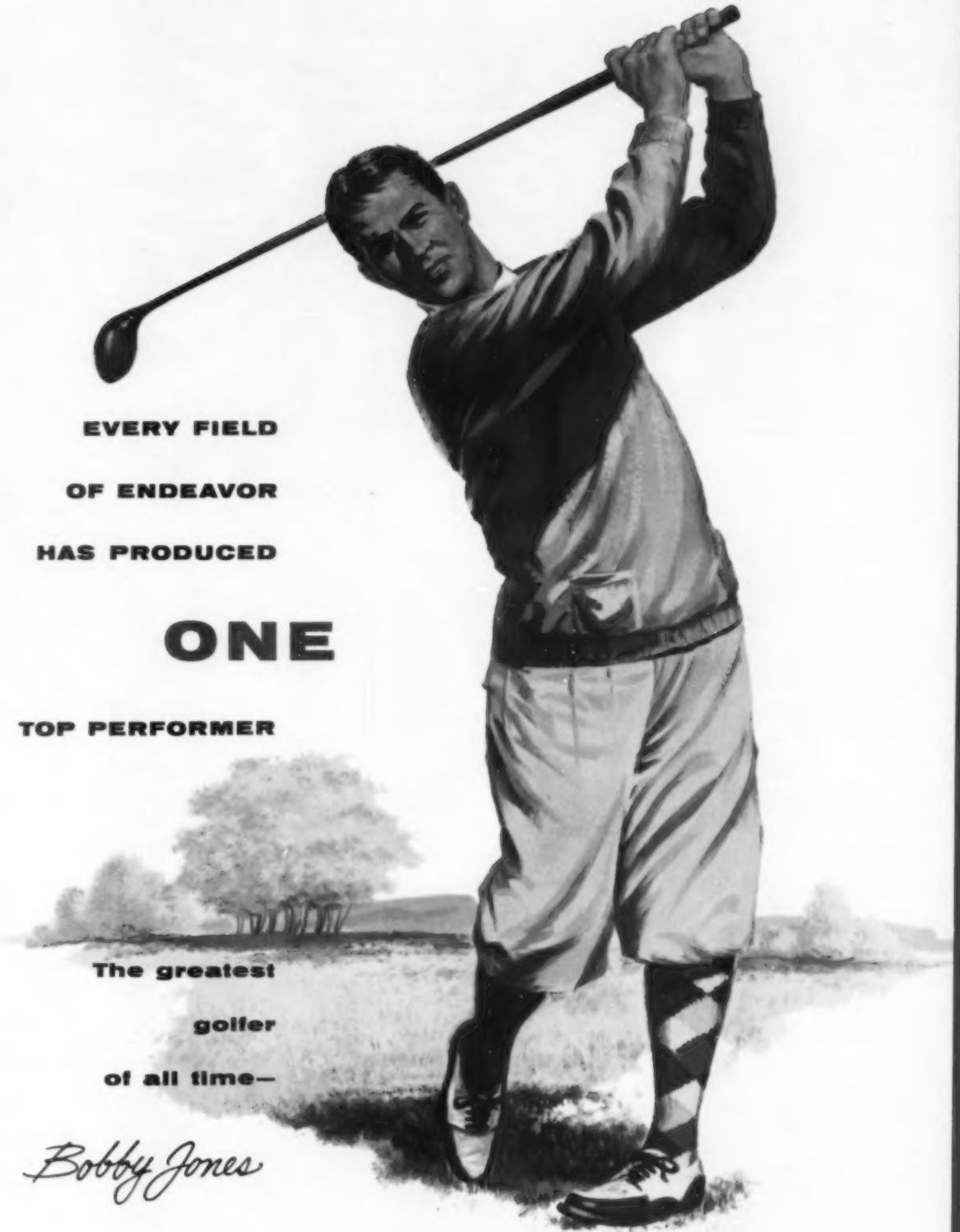
Placing recovery on an acreage basis, cumulative production of 2500 bbl an acre, based on some 25 to 30 ft of net pay, would be viewed as an effective operation. While double or triple this figure has been obtained in isolated cases, most operators have planned successful ventures on considerably less than this value. Because of the wide range of recoveries experienced in the past, it becomes obvious that specific study is needed to ascertain where within the range a given property should lie.

A Simple Analysis. It is revealing to contemplate how relatively poor the flood mechanism can be yet still produce equal oil on secondary as on primary. For example, if one assumes that only half the oil in place at the start of injection will be flushed from only half the total reservoir volume, the rest being untouched by water, then the product of ½ and ½ is ¼, which states that only one-fourth of remaining oil in-place will be produced by injection. If the primary recovery factor were 20 per cent of original oil in place, then the product of ¼ and (1 — 0.20) is itself equal to 1/5 or 20 per cent, the secondard recovery factor in terms of the total original oil in place. In this example, primary and secondary recovery factors are equal with not too stringent assumptions made as to sweep and flushing efficiency. It is the channeling of water, the loss of water into thief zones, formation plugging by poor quality water, together with the other fluid and reservoir properties previously discussed, that, if neglected, will prevent the flushing of half the oil from half the volume.

Margin of Error. Predicted recovery



Typical performance curves based on the successful water-flooding of a 35-acre tract in North Texas. Note increasing injection pressure for relatively constant injection rate during declining rate of flood oil production.



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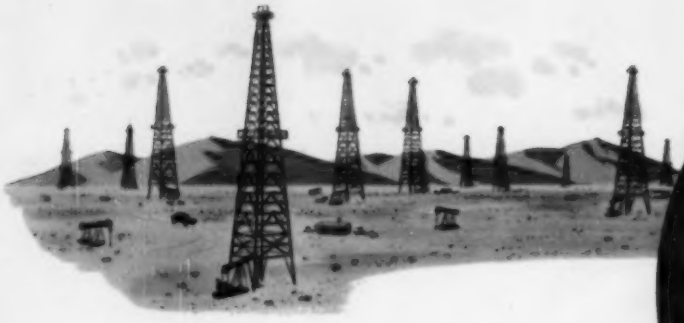

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of waterflood oil can never be more than an estimated quantity. What is important, though, is the type of estimate that is made. One estimate may be based on detailed calculations using large masses of factual data. Another estimate, such as that in the preceding paragraph, may be made on pure and simple assumptions and rules of thumb. Unfortunately, the term "estimate"applies to both methods. The difference between the two is the probable error in the answer obtained. The detailed approach might indicate that between 400,000 and 600,000 bbl should be recovered from a given project. The rank estimate might also hit the nail right on the head, but with no basis of the probability. This latter answer would be 500,000 bbl plus or minus 500,000 bbl. Those engaging in waterflooding are entitled to know the margin of error in the estimated recovery in order that they may judge for themselves the degree of risk which they care to assume.

Value of Detailed Studies. For large floods, detailed calculations are always made to predict the future performance of producing wells with respect to the producing water-oil ratio and the cumulative water injection after reservoir fill-up. Other calculations are made to determine the rate of flood advance and the time to obtain oil breakthrough. Such calculations are based on well-founded theory, which in turn embodies certain assumptions.

While theory is never precisely correct in practice, results so obtained furnish a reference to which actual results may be compared. Significant divergence between theory and practice can point out early in the flood whether sweep efficiency is approximately as estimated or whether water is channeling or being diverted to no purpose. While very few operators would now be willing to inject enough water to fill up his reservoir several times over with no oil returns, it is apparent that the earliest possible detection of unforeseen conditions is of economic importance. Theory will tell whether oil recovery in the field is relatively high or low for the given average water-oil ratio actually being produced in the field. In short, the probability of an operator's meeting his original estimates or the need for corrective measures are indicated in the comparison of fact with theory. The practical value of theoretical studies is the greater when detailed data on similar floods in the immediate area are not available. To the extent that reservoir conditions are equivalent, it is always a good idea to compare one's own progress with that of his neighbor.

Flood Life. The life of a flood depends on injection rates, well-spacing, and the rate of development of the en-

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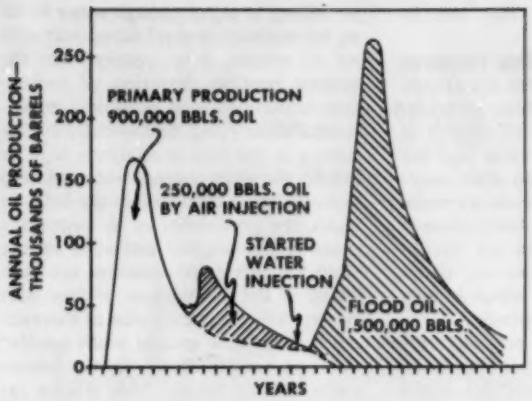


Example of an unusually successful water-flood based on the performance of a 300-acre project in a shoestring sand of eastern Kansas. With favorable reservoir conditions and good operating practices, waterflooding recoveries in excess of 5000 bbl an acre have been achieved.

tire tract for flooding. It may seem that floods survive possibly 15 or 20 years. In part, this effect is due to the gradual development of the property. The formation of an oil bank in the pilot flood will encourage expansion of the project. Further expansion feeds on continued success. Complete development of a large tract is not an instantaneous process. Initial returns will be plowed back into the business. Actually, the life of any one 5-spot may be on the order of 5 to 8 years.

Margin of Profit

Source of Profit. Generalizing on matters of cost is treading on very thin ice. Effort has been made in this series to illustrate that cost varies with methods employed in specific situations. Nevertheless, an example may serve the purpose of making a few significant points. Let us assume the price of oil was $2.90 per barrel. At the abandonment of the project, the operator's expense was approximately as follows in the distribution of each $2.90 produced:

(1) One-eighth royalty, 37 cents.
(2) Land acquisition, 10 cents.
(3) Development, 70 cents.
(4) Operating, 88 cents.
(5) Severance and ad valorem taxes, 25 cents.
(6) Overhead, 10 cents.
(7) Profit, 50 cents.

In this case, development and operating costs took the largest portions. The royalty owner at no risk came out very nicely at 37 cents (less tax) as compared to the operator's 50 cents. Land acquisition included the cash bonus, overriding royalty, and/or oil payments. Overhead and taxes were essentially fixed. The operator took what was left, and therein lies the challenge.

Profit Leverage. Any reduction in development and operating costs will reflect as increase in profit. The profit leverage is great. If a simple closed-type water system would have worked with equal effectiveness as an over-designed open system with a reduction of 25 cents per barrel in total operating costs, the profit would have been increased by 50 per cent. Furthermore, if wells could have been completed on 10-acre spacing at higher injection pressure rather than on 5-acre spacing, then an additional 25 cents per barrel might have been saved in development costs for a total profit of $1 per barrel, which represents doubling the original profit.

Leverage also works in reverse. Suppose extensive remedial work, for which no allowance had been made, became necessary. Operating costs were increased by 25 cents per barrel. On top of that, the price of oil dropped 25 cents per barrel. In this situation, profit would have been completely wiped out. The project would have been continued, of course, to return the invested capital even without profit. Since profit is the margin of safety that protects investment, prospects with great inherent risks should indicate wider profit margins to retain their attractiveness.

The Value of Land. Another observation from the hypothetical expense given above is that there is not much room for generosity in acquiring land. Those who hold stripper acreage and choose to do their own flooding can add the land cost factor to profit and be thankful. Those who hold the acreage and do not elect to assume the risk of profit or loss by flooding should recognize that any other operator cannot afford to pay a big cash price or override for the opportunity of taking risks that the owner does not want for himself.

Imposition of an excessively high override on the buyer will cause premature economic collapse of the project to the detriment of all. This does not imply that it is necessary to give away good, floodable acreage. Very satisfactory arrangements can be made whereby the original lease holder may participate after payout, provided he is willing to share risks to the extent of deferring his income. High risk prospects can be negotiated at a given price on purchase option arrangements, which may be exercised if the flood is successful. For low risk, good quality prospects, the highest cash offer or override may not represent the seller's best deal.

Well Workover Expense. With regard to operating costs, the major items are: Water for injection, lifting, and well workover expense. Water costs tend to remain fairly constant over the life of the project. Lifting costs increase with time as the produced water-oil ratio rises. The extent of remedial work necessary will depend on the age and condition of equipment, corrosive factors, competency of the formation, completion methods, water breakthrough characteristics, and many other relationships. The necessity for workovers must be faced realistically in the estimation of future profit.

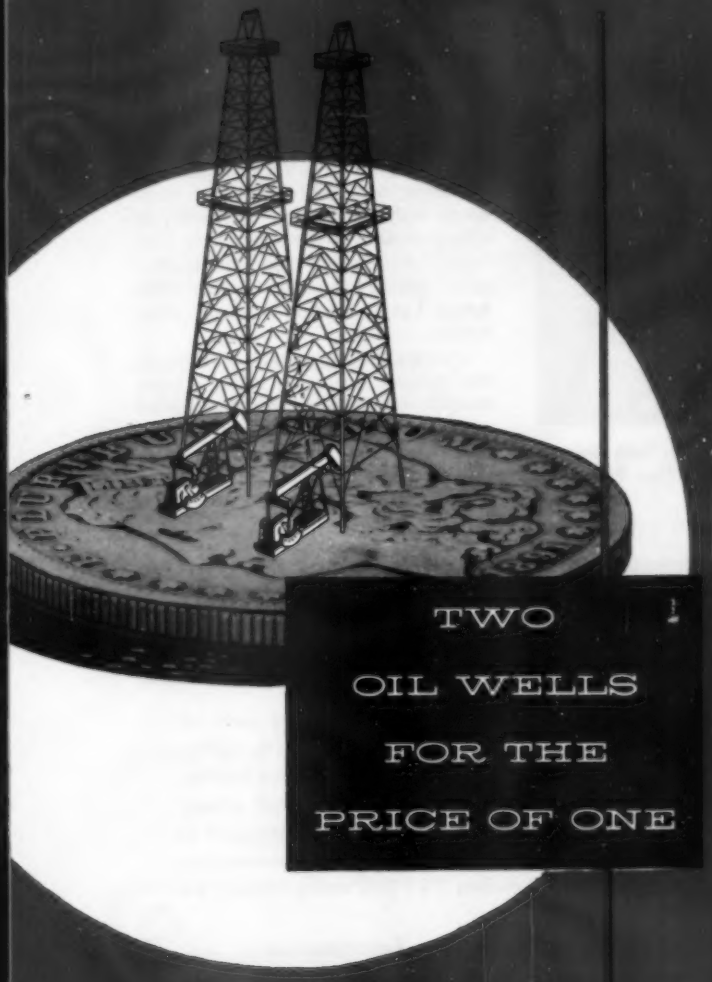
Development Costs vs Spacing. In the sample breakdown of expense borne by a barrel of oil, 70 cents was allowed for development. Assuming a recovery of 1500 bbl an acre, one is looking at about $1000 per acre development cost. For pattern floods, this figure would presumably be too low on the average. For edgewater injection, it might be too high. The point is that for 5-acre spacing one has $5000 per well with which to work. For 10-acre spacing, one has $10,000 at the same per barrel development cost. This illustrates very roughly the importance of well spacing. As in primary production, spacing can economically be no closer than where the oil recovered per well just pays for the facilities to produce it.

Collateral Value. Potential water floods have no loan value at the bank. Development and initial operating capital is venture money. When success becomes assured, a flood property may then be expected to have collateral value commensurate with the proved reserves. As a risk enterprise, waterflooding now enjoys a high standing among investors because of the relative safety of the investment in the light of present-day knowledge. Those with floodable stripper acreage should encounter little difficulty in locating others who are anxious and able to assume all or part of the initial financial burden.

Acknowledgment

The author acknowledges the vast number of workers who through individual and group effort have steadily advanced the science of water injection to its present status. Were the reporting and discussion of technical findings and the exchange of operating ideas not a part of our way of life, summarization and interpretation as undertaken by the writer would have been impossible. ★ ★ ★

A PROGRESS REPORT ON OILMASTER DUAL ZONE PUMPING EQUIPMENT



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Gulf Oil sets precedent in what is believed to be the first sale of crude by automatic control devices

Oil Run Continuously from Stock Tanks to Pipe Line

First sale by automatic custody transfer was made from this tank battery on Gulf Oil's Ames Lease in the Bloomer Pool, Kansas, to the Kaw Pipe Line Company, December 22, 1955.

MANY oil companies are on the brink of entering "automatic custody-transfer" agreements with pipe line companies, but Gulf Oil Corporation is believed to be the first to actually accomplish this practice.

On December 22, 1955, Gulf in cooperation with the Kaw Pipe Line Company effected the sale of crude oil by means of automatic tank-battery control equipment. This means that the oil is automatically measured and run into the pipe line company's gathering system without manual operation, and that payment for the oil run is made in accordance with corrected volumes as measured by the system.

After considerable amount of time and effort had been given the problem, an actual demonstration was placed in operation in the Glenn Pool of Oklahoma early in 1954. A year later, an arrangement was made with the Kaw Pipe Line Company to install this automatic custody battery on the Gulf Ames Lease in the Bloomer Pool, Kansas.

Essentially, the system consists of two parallel measuring tanks, a bs&w monitor, temperature recording instruments, a sampling device, and an electrically operated system that automatically controls the filling and dumping of the measuring tanks. ★ ★ ★

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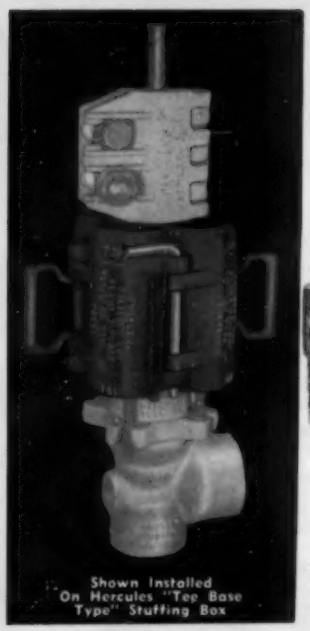
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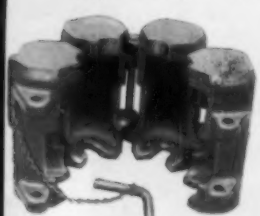

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Modified completion equipment is explained by Don Taylor, left, Otis Pressure Control, Inc., while Bob Crain, also of Otis, M. L. Lemonds and W. H. Kilgo, both of Kerr-McGee, and M. L. Kueffer of Baker Oil Tools look on. Taylor holds both crossover assemblies while the upper-seal nipple assembly with landing nipple and side-port unit is shown in background.

P 459.6

Three packer seal nipples go in on bottom of tubing string to seal off lower production packer. Note perforated nipple connected below bottom seal nipple.

Upper-seal nipple assembly and hydraulic tubing hold-down (at top) are run in on tubing. To seal off upper packer, only two seal niples were used.

Gas from Middle Zone Lifts Upper Zone Oil in . . .

Modified Multiple-Well Completion

Lower zone oil flows straight through tubing.

Bob L. Crain
Otis Pressure Control, Inc., Oklahoma City, Oklahoma

Burrell G. Taylor
Kerr-McGee Oil Industries, Inc. Oklahoma City, Oklahoma

A slight modification of specialized completion equipment permitted the use of gas from a middle zone to lift oil from an upper zone while a third bottom zone produced oil straight through the tubing. This modified triple completion was made in a well operated by Kerr-McGee Oil Industries, Inc., in the Northeast Purdy Field near Lindsay, Oklahoma.

There are three productive zones in this field:

1. The Springer sand at 9940 ft (bottom zone).
2. The Lower Hart sand at 8700 ft (middle zone).
3. The Upper Hart sand at 8600 ft (upper zone).

The Springer zone produces 37.7 deg API gravity oil, the Lower Hart produces gas, and the Upper Hart produces 40 deg API gravity oil in this well. Although the Lower Hart produces gas and the Upper Hart produces oil, these Deese sands are considered as one common source of supply, and it is not necessary to segregate the production.

A short production history showed the Upper Hart zone would not flow its allowable, so gas from the Lower Hart was used to assist lifting the oil

to the surface through the tubing-casing annulus. Oil production from the Springer sand (lower zone) was allowed to flow directly through the tubing. All three zones were treated by sand-oil fracturing during the completion stages.

The Completion Operation

This well was drilled to 10,115 ft and 7-in. OD 23- and 26-lb casing was run and cemented at 10,084 ft. The cement plug was drilled out to 10,032 ft, and the well was then perforated successively in the Springer, the Lower Hart, and Upper Hart sections. Fig. 1 illustrates the relative positions of the three perforated zones.

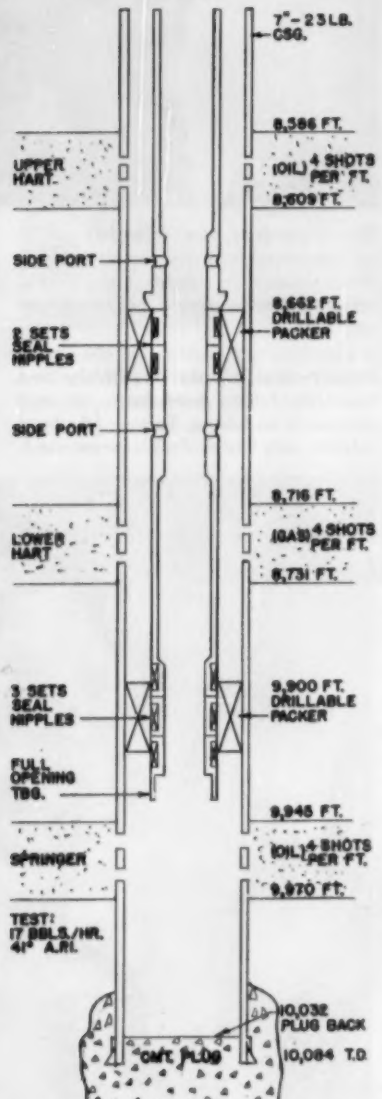
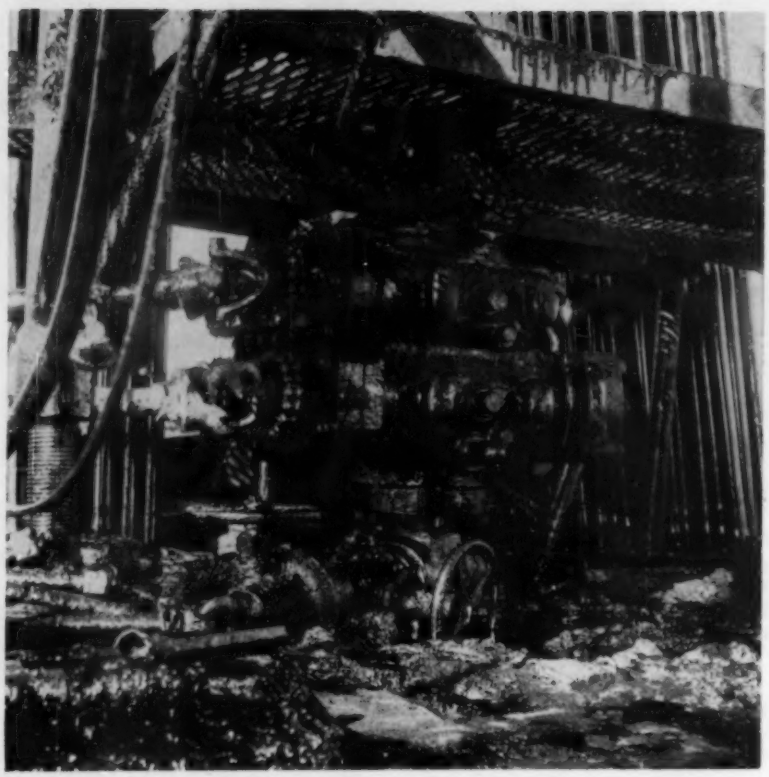


FIG. 1. **Tubing string assembly** in relationship to packer settings and to the three producing formations in this modified triple completion.



Dual-seal blowout preventer used as safety precaution in completion operation. Equipment is covered with 25 deg API gravity oil used in controlling well during completion.

A retrievable bridge plug and hookwall packer were run in on tubing and the Springer zone fracture treated with sand-oil, then tested. The bridge plug and packer were then moved up the hole, and it was determined that communication existed between the two Hart zones. A drillable bridge plug was placed just below the Lower Hart perforations and both sets of Hart perforations were squeeze cemented. After re-perforation and sand-oil treatment, the Lower Hart zone flowed gas at the rate of 1300 MCF daily. The Upper Hart zone was re-perforated and sand-oil treated by again using a retrievable bridge plug and hookwall packer combination. The Upper Hart zone flowed through the tubing satisfactorily, and the bridge plug and packer were pulled out of the hole. The drillable bridge plug below the Lower Hart was drilled out and the hole circulated clean.

It was decided to dually complete the well in the Springer and Upper Hart oil zones, with the Lower Hart zone isolated in the casing. Drillable-type production packers were run on a wireline and set at 9900 ft and 8662 ft. Three seal nipples were run in the tubing string to seal in the lower packer and two seal nipples were run to seal in the upper packer. A side-door choke nipple was placed in the string above the upper packer to facilitate initiating flow from both zones.

Both oil zones were kicked off, with the Springer flowing through the tubing and the Upper Hart through the tubing-casing annulus. The Upper Hart production rate was not deemed satisfactory, with insufficient gas to continue lifting the allowable, and an investigation was made with the idea of utilizing gas from the Lower Hart section to help lift oil from the Upper Hart. A tool that could be run and recovered with wireline tools was considered advantageous in that a positive bottom hole choke could be changed quickly without the necessity of pulling the tubing string.

Modified Triple Completion

The well entered its final completion stage as it became evident that it was practical to admit a small amount of high-pressure gas from the middle zone to lift oil produced from the upper zone. Fig. 2 illustrates the modification in two crossover assemblies that made this completion possible. This unit consists of two, concentric crossover assemblies with an interchangeable flow bean between.

The tubing was pulled from the well

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in order to check sanding condition in the Springer zone, and at this time two side-port nipples were installed in the tubing string as shown in Fig. 1. As the Springer zone failed to flow after tubing was run, a double packoff assembly was run on wireline and ports in the two side-port nipples were sealed off. The Springer zone was then retreated with sand-oil down the tubing. A leak occurred in the seal assembly, and it was necessary to pull the tubing and circulate out the sand that settled out.

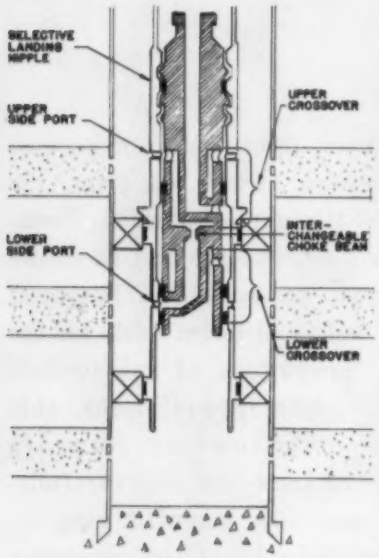

FIG. 2. **Double crossover assemblies, shown schematically, were slightly modified and run in the tubing on wire line. Flow of gas from middle zone is channeled into casing annulus to lift Upper Hart oil.**

The complete tubing assembly was then run in the hole and both zones allowed to clean up through the tubing string. The wireline crossover assembly was then run with a 4/64-in. flow bean installed between the crossover mandrels as shown in Fig. 2. The flow bean allowed a controlled amount of gas to flow from the Lower Hart into the tubing-casing annulus to lift oil from the Upper Hart.

On January 27, 1956, gas-oil ratio tests were run, and the Upper Hart zone flowed 64 bbl of oil in 24 hr through a 14/64-in. choke with flowing tubing pressure of 200 lb. and gas-oil ratio of 5404 to 1. (Limiting gas-oil ratio from the Hart zone is 4000 to 1.) Based on previous gas-oil ratio on the Upper Hart zone, a flow of 269,000 cu ft of gas per day was indicated from the Lower Hart. The Springer zone flowed intermittently and produced 25 bbl in 24 hr. ★ ★ ★

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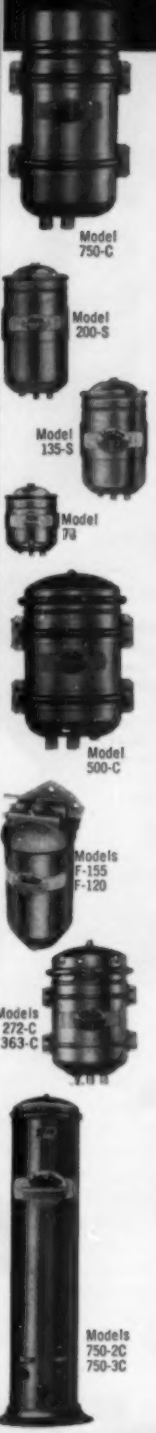

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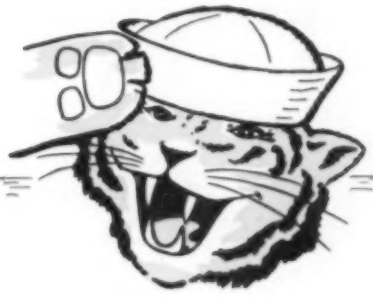

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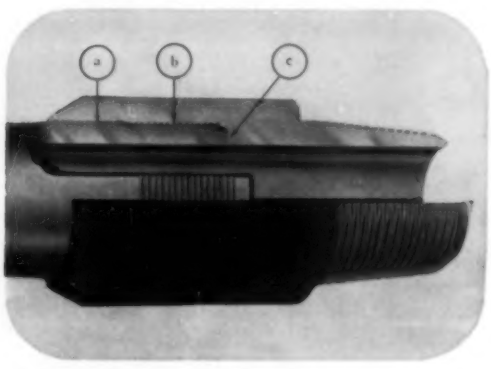

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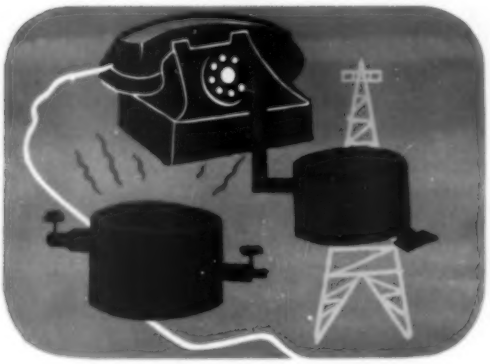

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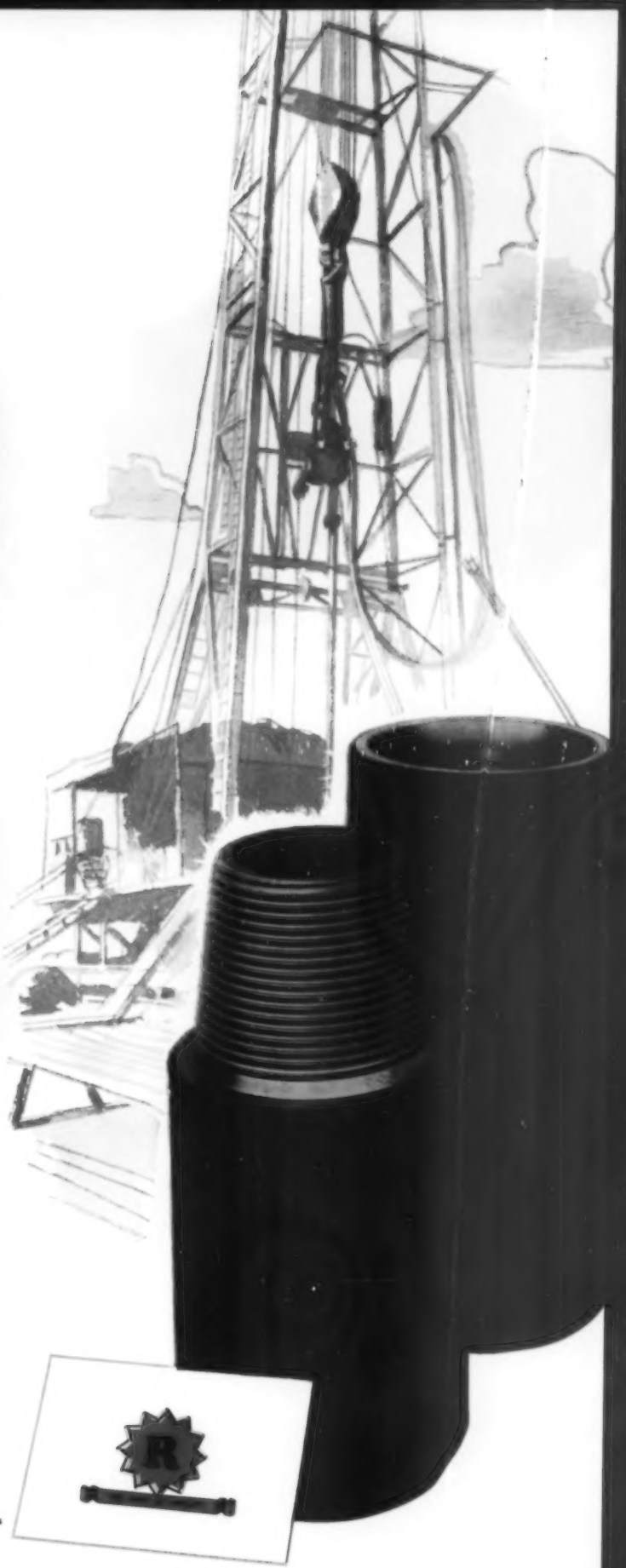

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. . . Six Years Later

R. Leland Redline, Jr.
Consulting Geologist, Midland, Texas

A new geological structure came into popular discussion in 1949 and posed a brand new kind of challenge to the geologist. This type of petroleum trap was extremely difficult to delineate by any means, and exploration for reef-type traps generally took the form of a "trend" play. Such was the case when George P. Livermore Inc. of Lubbock, Texas, took a drilling deal to drill a

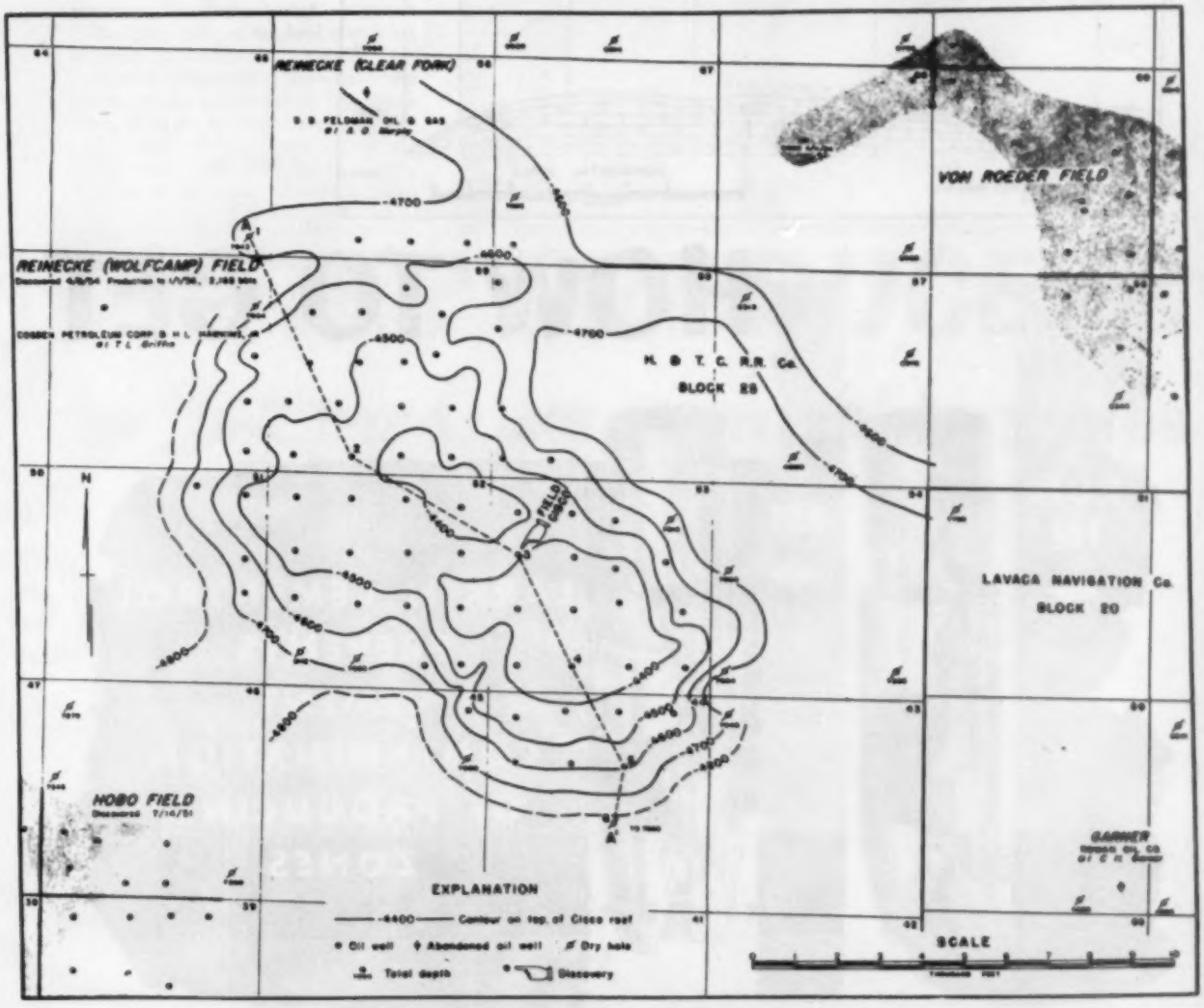

FIG. 1. **Reef structure of the Reinecke field** in Borden County of West Texas. Contour intervals are 100 ft. There are 2833 productive acres in this reef-type field.

wildcat 14 miles southeast of Gail, Texas. Subsequent developments pointed out clearly that regardless of conflicting information to the contrary, when a trend of production is established, such as the "reef trend," it is worthwhile testing for the spectacular results that can be obtained. The No. 1 Reinecke discovered production in the Cisco group of the Pennsylvania on February 2, 1950, and now, six years later, the Reinecke field includes 69 wells within 2833 productive acres. After development, reservoir studies showed that the field's original reserves were about 111,000,000 bbl of stock tank oil. The field has already produced over 13,000,000 bbl of oil.

The Reinecke field is in the southeast corner of Borden County, in West Texas, 14 miles southeast of the town of Gail. It is in Block 25, Houston and Texas Central R.R. Company Survey. The region is arid and supports mesquite and range grass, with farming operations consisting of cotton and feed. The Colorado River flows into the Upper Colorado Municipal Water District (Lake Thomas), approximately 2 miles northeast of the field. Surface elevations at the well locations range from 2370 ft to 2300 ft. Surface formation consists of recent alluvium and undifferentiated red beds of the Triassic system.

Discovery history. The Reinecke

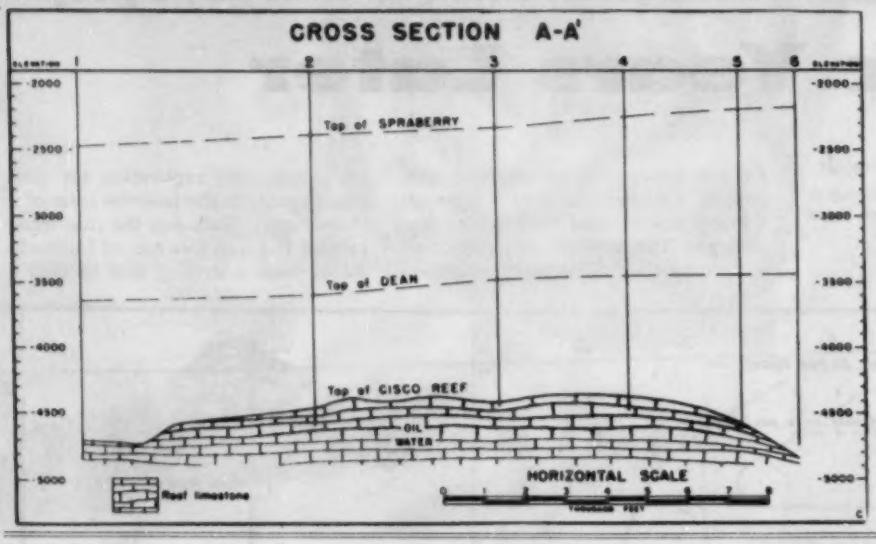

FIG. 2. **Cross section of Reinecke field** taken through points A - A' on map shown in Fig. 1. Axis of the field is northwest-southeast.

LARKIN LEADERSHIP HAS BEEN EARNED

field is one of many discovered since 1948 along the "reef trend" which extends in an arc across Kent, Scurry, Borden, Howard, and Dawson counties. Availability of a drilling deal enabled George P. Livermore Inc. to drill and complete as a discovery the No. 1 Reinecke in the Cisco group of the Pennsylvanian system. It is believed that deeper penetration into this system also resulted in many of the wells being completed in the Canyon group, which is normally encountered along the entire "reef trend."

The discovery well was completed February 2, 1950. Subsequent drilling has resulted in a total of 69 oil wells consisting of 65 flowing and 4 pumping. Great Western Drilling Company, Standard Oil Company of Texas, Cosden, Magnolia Petroleum Company, Heyser and Heard, Chapman and McFarland, J. I. O'Neil, Pan American Production Company, and Murphy Baxter operate producing properties within the limits of the field consisting of some 2833 acres.

Field development. After completion of the George P. Livermore, Inc. (now Great Western Drilling Company) discovery well, there ensued a rapid development of the field by the other companies. To date, the only horizon producing commercial quantities of oil

TABLE 1. Reinecke Field production history.

Month	Year	Monthly production, bbls	Cumulative production, bbls	BHP at −4400 ft
February	1950	2,537		3167
March		5,210		
April		16,169		
May		28,924		
June		53,701		
July		110,585		
August		132,496		
September		204,668		
October		210,791		
November		211,484		
December		225,042	1,233,234	
January	1951	273,814		2951
February		209,763		2953
March		254,368		2958
April		226,646		2955
May		244,153		2937
June		239,055		2918
July		259,372		
August		261,468		
September		271,040		2896
October		278,253		
November		276,415		
December		259,536	4,303,830	2834
January	1952	255,350		
February		253,128		
March		278,166		2781
April		253,534		
May		151,726		
June		224,507		2726
July		214,265		
August		233,093		
September		249,026		2685
October		267,270		
November		264,687		
December		265,040	7,223,030	2596
January	1953	255,152		
February		226,989		
March		241,467		2554
April		217,973		
May		226,775		
June		230,097		2491
July		238,834		
August		238,478		
September		217,023		2433
October		217,665		
November		192,538		
December		191,377	9,919,005	
January	1954	189,806		
February		128,283		
March		146,495		2405
April		146,566		

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TABLE 1. Reinecke Field production history. (Continued)

Month	Year	Monthly production; bbls	Cumulative production; bbls	BHP at —4400 ft
May		139,423		
June		139,373		
July		130,795		
August		122,507		
September		122,577		2378
October		123,970		
October		123,970		
November		122,801	11,558,549	
December		131,864		
January	1955	146,134		
February		129,241		
March		144,433		2356
April		137,891		
May		128,382		
June		120,506		
July		121,995		
August		120,928		
September		122,121		2334
October		129,325		
November		129,596		
December		138,321	13,127,424	

NOTE: During the fire of Pan American's No. 2 Hill Sec 52, Blk 25 additional bottom-hole pressures were run which are listed below.

Date	BHP at —4400 ft
6-12-50	3149
6-13-50	3153
6-14-50	3131
6-15-50	3131
6-16-50	3121
6-17-50	3116
6-18-50	3101
6-19-50	3090
6-21-50	3043
6-23-50	3032
6-26-50	3028
7- 3-50	2958
7-10-50	2971
7-17-50	2985
7-24-50	2987
7-31-50	2995
8- 7-50	3008
8-14-50	3011
8-28-50	3015
9- 3-50	3021

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and gas within the limits of the field is the Pennsylvanian, although Rowan Oil Company No. 1 C. H. Garner was completed May 13, 1951 in the Clear Fork group for a daily pumping capacity of 133 bbl of 27-gravity oil and no water through perforations between 4242 and 4272 ft after having been plugged back from a total depth of 7520 ft.

It was recognized as a discovery well, producing 3566 bbl of oil in 1951 and 847 bbl during 1952. It was plugged and abandoned on October 26, 1952. Location of this well which prompted the designation of the Garner field (see accompanying map) is in the extreme southeast corner of Borden County, Texas.

D. D. Feldman Oil and Gas No. 1 A. O. Murphy, located near the north boundry on the accompanying map was completed October 3, 1952, for a daily pumping capacity of 179 bbl of 38-gravity oil after being plugged back to 4919 ft from a total depth of 6995 ft. It was designated by the Railroad Commission as the Reinecke Clearfork field. The well produced 2610 bbl of oil in 1952 and 1055 bbl during 1953. It was plugged and abandoned January 21, 1954.

The Cosden Petroleum Corporation completed on April 8, 1954, a well in section 60, Blk 25, H&TC R.R. Company Survey. It is believed to have been completed in the Wolfcamp series of the Permian system. Production to January 1, 1956, amounted to 2168 bbl of oil. This well is near the northwest corner of the accompanying map.

Reservoir rock. Maximum gross thickness of the reservoir rock is on the order of 300 ft. The reef limestone consists of white and buff fossiliferous dolomite and limestone with fractures and vugs throughout. In several of the wells, a thin dolomitized zone was found immediately above the main reef. In one well, Cosden Petroleum Corporation No. 2 Holbein, such a zone occurs several hundred feet above

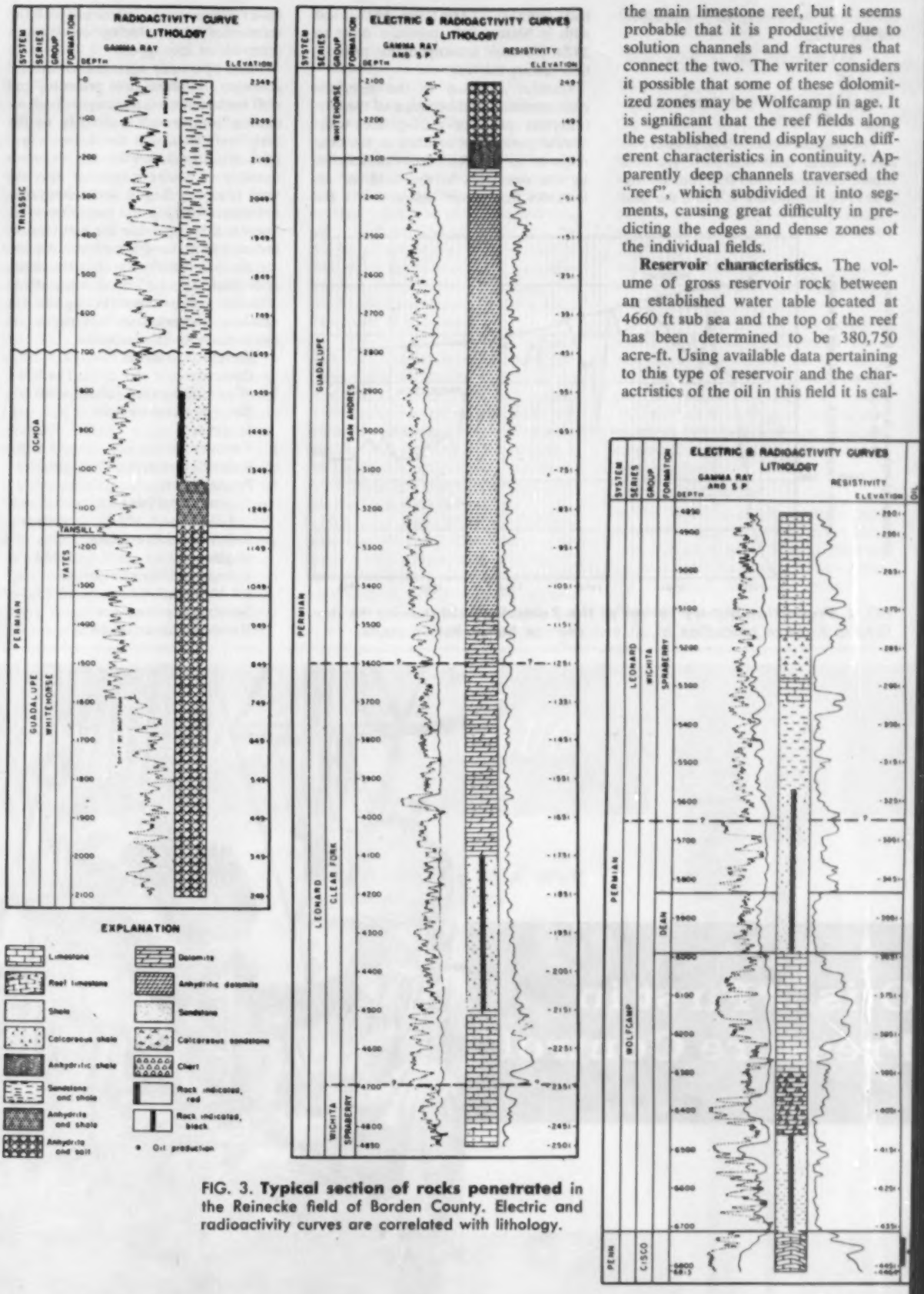

FIG. 3. **Typical section of rocks penetrated** in the Reinecke field of Borden County. Electric and radioactivity curves are correlated with lithology.

the main limestone reef, but it seems probable that it is productive due to solution channels and fractures that connect the two. The writer considers it possible that some of these dolomitized zones may be Wolfcamp in age. It is significant that the reef fields along the established trend display such different characteristics in continuity. Apparently deep channels traversed the "reef", which subdivided it into segments, causing great difficulty in predicting the edges and dense zones of the individual fields.

Reservoir characteristics. The volume of gross reservoir rock between an established water table located at 4660 ft sub sea and the top of the reef has been determined to be 380,750 acre-ft. Using available data pertaining to this type of reservoir and the charactristics of the oil in this field it is cal-

culated to have originally contained the following:

a. 111,000,000 bbl of stock tank oil.
b. 133,200,000 mcf dissolved casinghead gas.

The original bottom-hole pressure of the Reinecke field was 3167 psi at a subsea datum of 4400 ft. From February, 1950, to January 1, 1956, the field had produced 13,061,395 bbl of oil with a bottom-hole pressure drop to 2324 psi (see accompanying production history curves).

Careful attention to the reservoir characteristics and behavior of the bottom-hole pressure during the withdrawal period has resulted in periodic requests to the Railroad Commission by the operators in the field for allowables that would best conserve the reservoir energy in accordance with the economics of producing oil from a reservoir of this type.

Field operators agreed that careful attention to bottom-hole pressures and well performance is necessary. Such attention contributed materially to the early realization that the reservoir was probably supplied with an abundant quantity of water migrating into the void space as the oil was withdrawn. Subsequent testing and reduction of allowable to compensate for bottom-hole pressure drop, have served to substantiate the original theory that the Reinecke field has an effective water drive.

Some factors contributing to the opinions expressed in this paper are listed below in tabular form.

a. Weighted average thickness ..... 134.5 ft
b. Water oil contact, subsea 4660 ft
c. Net pay based on core analysis ..... 69.2 %
d. Porosity ..... 13.4 %
e. Interstitial water ..... 19 %
f. Permeability
   (core analysis-to air) 146 md
   (PI tests-to oil) ..... 896 md
g. Relative volume factor, original 1.724
h. Compressibility of reservoir oil V/V/psi* 10-6 ..... 15.75
i. Saturation pressure at Reinecke datum of 4400

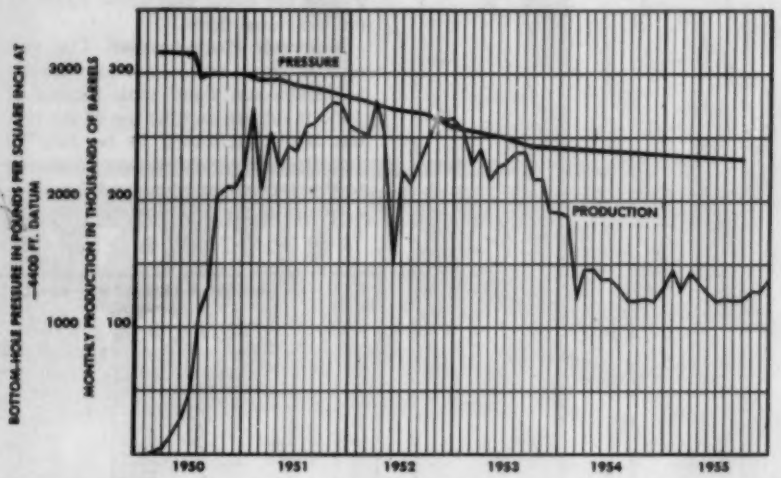

FIG. 4. **Production history curves of the Reinecke field** showing the relationship between production of oil and average bottom-hole pressure.

Otis..."First in Pressure Control"

ft subsea.....2010 psig

j. Original reservoir pressure at 4400 ft subsea.....3167 psig

Unfortunately, in the early life of the Reinecke field, one of the wells caught fire during a completion attempt. Pan American Production Company's No. 1 Holley burned out of control from June 11, 1950, to July 6, 1950. The sudden drop in bottomhole pressure during this period (see accompanying production history curves) and the subsequent rise after the fire was extinguished have led some of the reservoir engineers studying the field's behavior to estimate that approximately 70,000 stock tank barrels of oil were burned each day of the fire. This would represent a total of about 3,000,000 bbl of reservoir oil.

Production of salt water in the field is limited to seven wells producing from 2 per cent to 98 per cent of gross liquid produced. Total water produced to date is slightly over 1,000,000 bbl.

Drilling and completion practices. A uniform spacing pattern of one well to 40 acres was adopted by the operators in the field. Drilling was conducted with rotary tools of the conventional type. Drilling fluids varied from clear water to the top of the black shale then bentonitic mud to total depth to a strong bentonitic mud top to bottom.

Some lost circulation troubles were encountered after drilling into the reef. However, careful supervision of the mud weight minimized this difficulty.

Usually, an intermediate string was set between 2300 ft and 2400 ft and cemented to the surface. When this was not done, it was necessary to run a surface string to protect the surface waters encountered from 100 ft to 250 ft in depth. If the surface casing was run, the intermediate casing was still necessary but was not cemented from top to bottom. The oil string of casing was either set on top of the productive reef, or in the case of some operators, was set through to a predetermined depth, then perforated in the productive zones of the pay.

Completion practices did not vary considerably over the field. Usually the cement plug was drilled with water and mud and the hole cleaned to bottom. If the casing was set on top of the reef, the mud was displaced with oil or water and the well alolwed to clean itself. If the casing was set through the reef, the same procedure was followed to clean out the plug, then perforated.

The mud was then displaced with water or oil and the well usually cleaned itself. Some operators, fearing later trouble from mud lost in the reef while drilling, would wash the pay with small quantities of acid, usually not over 1000 gal. This would result in additional initial flow capacity, however, it is doubtful that it improved the actual capacity of the well to produce.

A vital lesson. Development of the Reinecke field points out the fact that regardless of conflicting information to the contrary, when a trend of production is established such as the "reef trend," it is worthwhile testing for the spectacular results obtained. In addition, it should be noted that even with careful attention to reservoir performance, withdrawals are still in excess of water migration into the reservoir. Such being the case, it seems imperative that a pressure maintenance program be inaugerated soon.

If this is not done it will result in additional loss of oil due to increased viscosity of the oil, and the formation of a gas cap after the saturation pressure is reached. The latter of course would result in re-working operations, which due to the completion practices employed in this field would be expensive and dangerous.

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References

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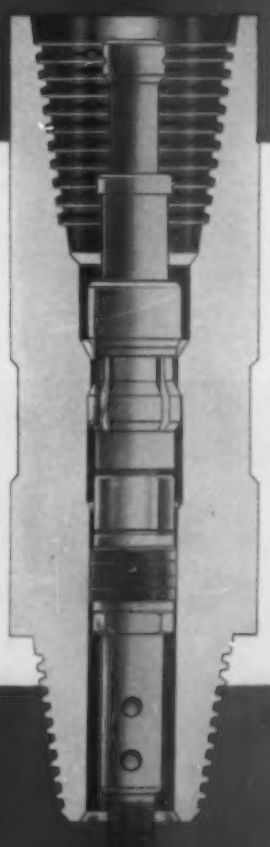

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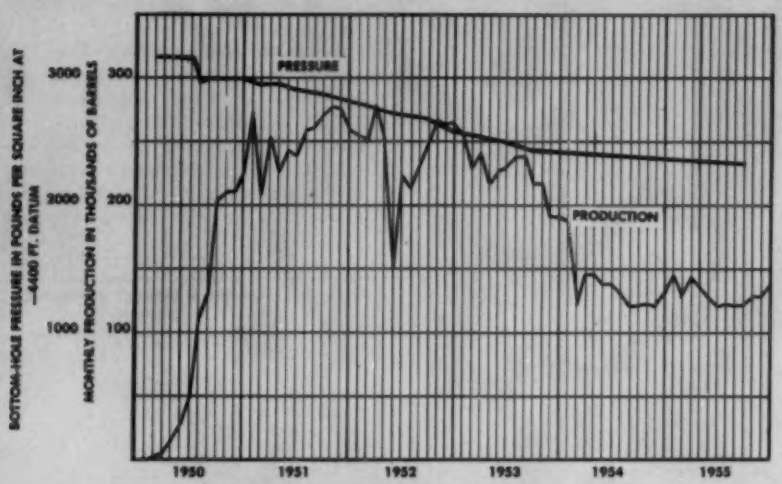

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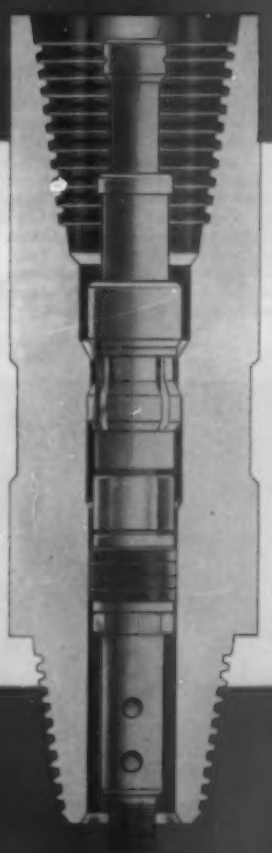

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Nomads of the Los Angeles Chapter were hosts to these international guests at their March meeting: Standing, Stewart M. Collester, Santa Fe Drilling, Australia; Gus J. Jure, Drilling and Exploration, Dhofar; P. Krijgsman, Bataafsche Petroleum Maatschappy, Indonesia; seated, Ted Kopp, D. E., Brazil; Leo L. Goss, Santa Fe, New Guinea; Herman Rynaard, B. P. M., Indonesia.

New Member: During his induction as associate member of Nomads, March meeting, Los Angeles Chapter, Harold H. Smith of H. C. Smith Oil Tool receives his lapel insigne from Art Marshall of the same company. Sergeant-at-arms Bill Brooks, (left), Byron Jackson Company, and Ritual Master Tom Martin (right), of R. J. Eiche & Associates are on hand for the proceedings.

THE OASIS — *A gathering spot for NOMADS*

Effective immediately, the new address for the executive offices of the National Board of Regents of Nomads is as follows:

P. O. Box 18161
Houston 23, Texas.

This is the same address as for the Houston chapter.

Seven of the eight past presidents, Los Angeles Chapter of Nomads, who attended the April meeting are shown here with the 1956 president are: Standing, Henry Pullman, Baker Oil Tools, 1943; Bob Eiche, R. J. Eiche and Associates, 1947; Bill Wilson, Web Wilson Oil Tools, 1952; Joe Schlarb of Emsco Manufacturing, 1954; seated, Ted Sutter, Baker Oil Tools, 1940; Elmer Decker, Martin-Decker, first president, 1939; Harry Hester of McCullough Tool, 1956; Ernie Fowks, Emsco Manufacturing, 1941. Present but not pictured was Roland Smith, Roland E. Smith Company, 1944.

Speaker of the evening and foreign guests at the April Nomads meeting in Los Angeles were: Standing, Edgar W. Carne Jr., Baash-Ross, Venezuela; Jack J. Parks, Mene Grande Oil, Venezuela; H. E. Giles, Stanvac, Indonesia; Jack P. Jeffers, Mindrill, Ltd., Australia; Roy K. Hautzinger, Baker Transworld, Canada; seated, J. D. Rowe and Mark R. Teague, Iraq Petroleum, Iraq; David Shonerd, Aerophysics Development, who spoke on missiles and space satellites; T. M. Warden, Drilling and Exploration, Brazil.

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4. *Zavalla, Texas*
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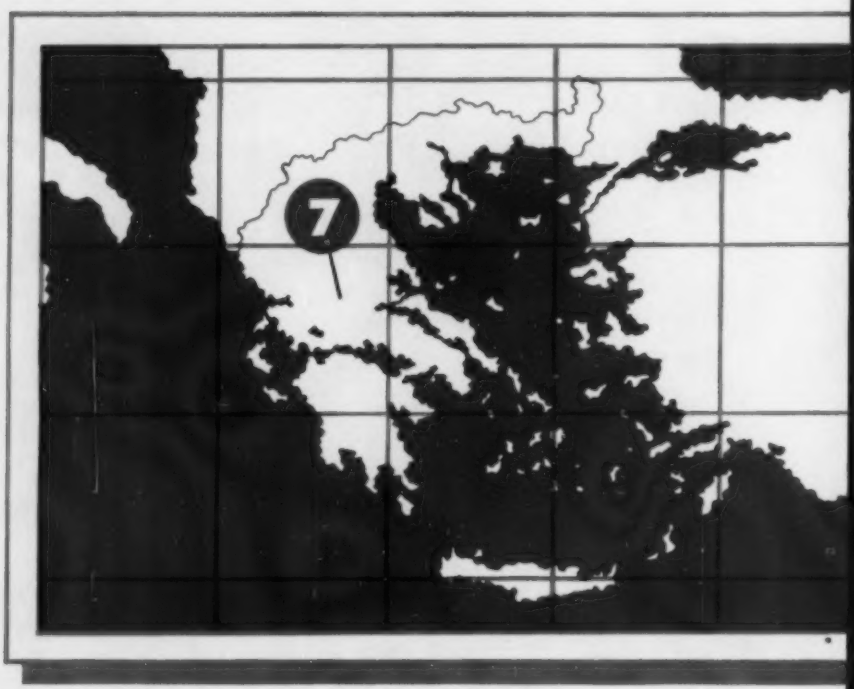
6. *Nova Scotia*
7. *Greece*
8. *Mexico*
9. *Hinson, Florida*

MILLS:

Malvern, Arkansas (barite)
Greybull, Wyoming (bentonite)
Brownsville, Texas (barite)
New Orleans, Louisiana (barite)
Lake Charles, Louisiana (barite)
Zavalla, Texas (clay)
Battle Mountain, Nevada (barite)
Hinson, Florida (clay)



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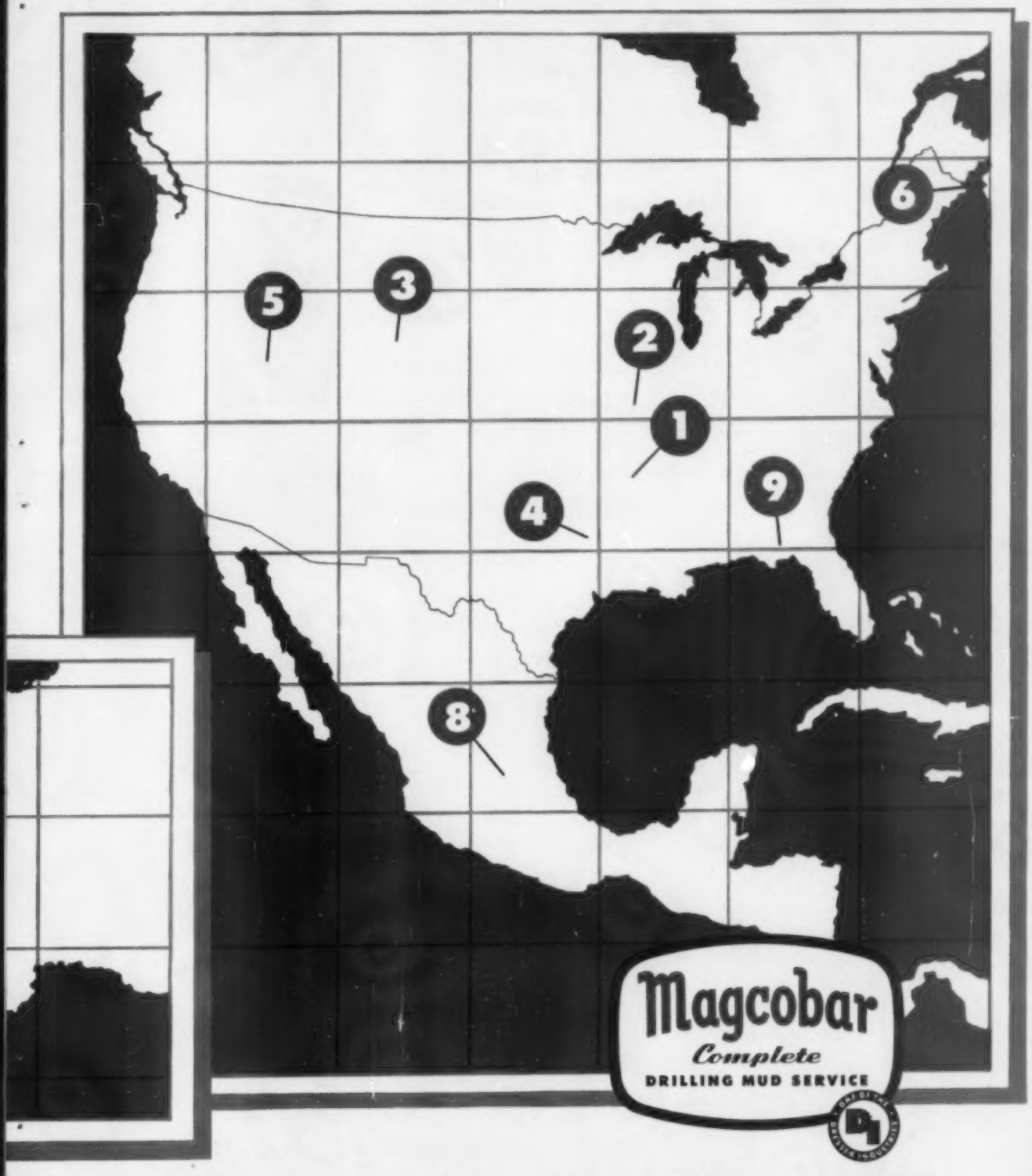
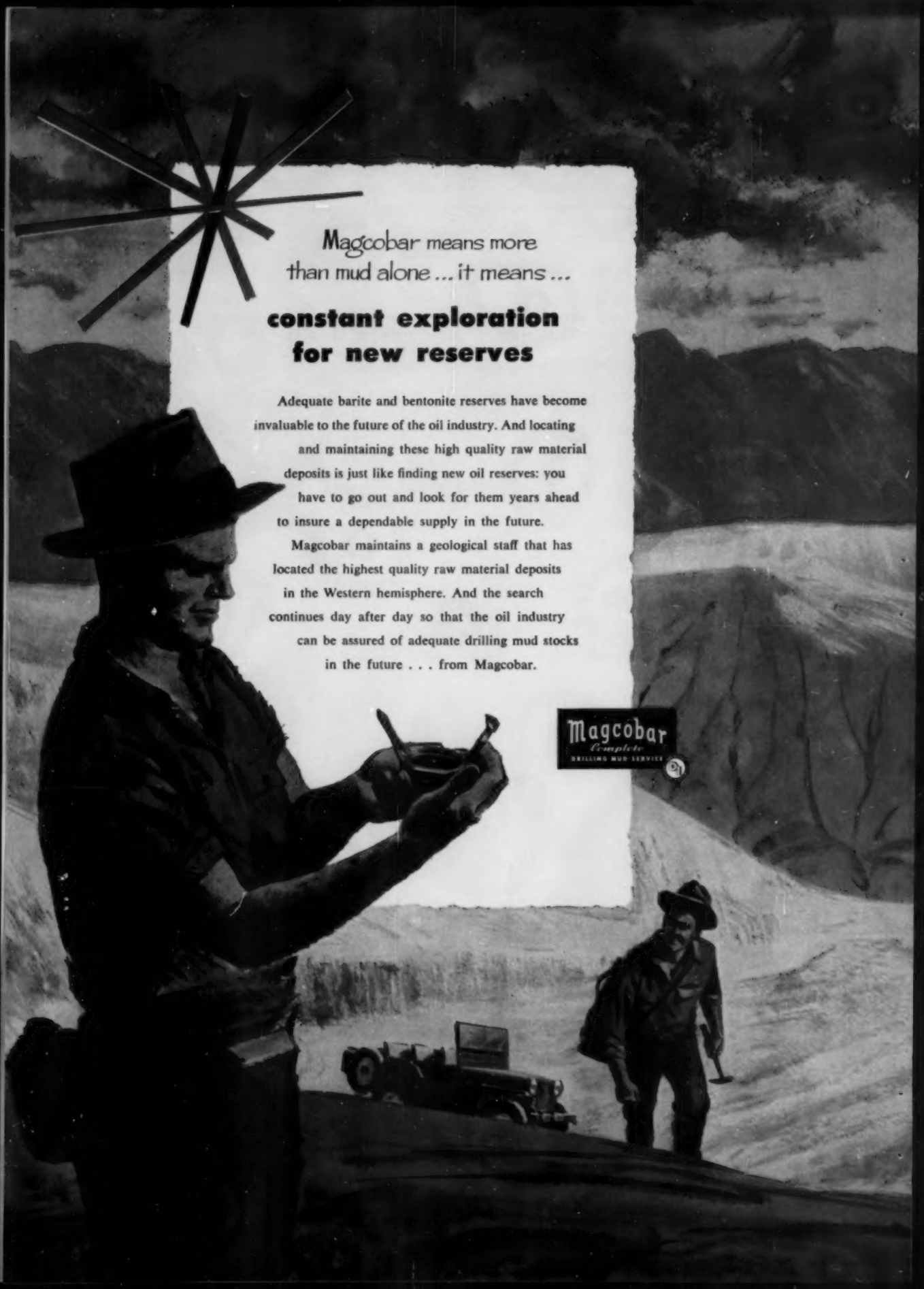


OF BARITE FOR DRILLING MUDS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Nomads Meeting Dates and Secretaries

New York Chapter, first Monday of the month, Hotel Roosevelt, New York. Executive Secretary, E. W. Hoeppner, in care of Hughes Tool Co., Room 4414, 30 Rockefeller Plaza, New York 20, N. Y.

Houston Chapter, second Monday. Ye Olde College Inn, Houston, Texas. Executive Secretary, Harry E. Estes, P. O. Box 18161, Houston 23, Texas.

Los Angeles Chapter, second Wednesday, Jonathan Club, Los Angeles, California. Executive Secretary, W. A. Sawdon, P. O. Box 848, Hollywood 28, Calif.

Tulsa Chapter, third Friday, Mayo Hotel. Executive Secretary, E. L. Thomas, P. O. Box 4033, Tulsa, Okla.

Dallas-Fort Worth Chapter, first or second Monday. Secretary, H. A. Davis, H. A. Davis Power Equipment Company, 2142 Irving Boulevard, Dallas, Texas.

One hundred and eighty Nomad members and guests attended the Houston April meeting to hear J. B. O'Connor, executive vice president of the Dresser Industries, relate his experiences in Russia and the Hydro-Drill acquired there. Foreign guests and dignitaries present were: G. H. Ratcliffe, Shell of Venezuela; W. B. Thomas, A-Z Export, Maracaibo, Venezuela; C. Hayden Dye, A-Z Export, Anaco, Venezuela; Willard Johnson, Magnet Cove Barium, Houston; Thomas E. McDowell, Petroleum Overseas Consultants, Houston; J. B. O'Conner, Dresser Industries, Dallas; Preston Dillon, Overseas Consultants, Houston.

Guests, in addition to the sixty members of the Houston Nomads Chapter present at the March meeting were: Jack R. Hamilton, Gulf Oil, Houston; Harold Vance, vice president, Bank of the Southwest, Houston, who discussed problems involved in applying for an oil loan; A. J. Thomson, Mosul Petroleum, Iraq; Kraus Earhadt, Texas Company, Houston, Jack Ballagh, Tex-Lube, Los Angeles.

President of the Tulsa Nomads Chapter Don Collins, (center) Republic Supply, welcomes back two Nomads, Gerald H. Westby, Seismograph Service, returning from Colombia and Venezuela; right, C. H. Keplinger, Keplinger & Wanenmacher, from Guatemala.

Foreign Visitors Committee, Tulsa Nomads, with the purpose of contacting and assisting foreign Nationals and American Nationals employed in foreign fields while they are visiting in the Mid-Continent Area. Attending an organization luncheon at the Tulsa Club were these Nomads: Seated, Howard Harmon, Pacific Vales; Jack Beesley, Baroid Division; Gerald H. Westby, Seismograph Service; J. J. Young, Reed Roller Bit; Ben F. Kelley, Ben F. Kelley, Inc.; standing: Keplinger, Collins, Roy R. Bush, Rockwell Manufacturing; Bob Glover, Baker Oil Tools; Oscar Irizarry, "Petroleo Interamericano."

IOCC Annual National Survey Shows . . .

Stripper Production and Reserves on Increase

Over one-fifth annual U.S. oil production as well as total recoverable reserves attributed to stripper well fields

OVER one-fifth of all the oil produced in the U. S. during 1954 came from stripper wells, according to the National Stripper Well Survey dated January 1, 1955, and recently released by the Interstate Oil Compact Commission of Oklahoma City, Oklahoma. Production from stripper wells that year amounted to 432,495,896 bbl, while the U. S. production (all liquid hydrocarbons) totaled 2,300,000,000 bbl. The report also showed that the total primary and secondary recovery reserves represented by stripper wells amount to over 7.7 billion barrels, or over one-fifth of the total proven reserves, both primary and secondary.

Stripper production has increased considerably from 1951 to January 1, 1955. Total annual production for these years was: 1951 — 341,000,000 bbl; 1952 — 374,000,000 bbl; 1953 — 384,000,000; and in 1954 — 432,500,000 bbl. This increase in production was accomplished in spite of the fact that annual abandonments were greater than ever before. In 1951, the survey shows 10,574 wells were abandoned; in 1952, 13,973 wells; in 1953, 13,278 wells; and in 1954, 11,318 wells were abandoned.

The number of stripper wells has increased only slightly. On January 1, 1955, there was a total of 340,276 stripper wells in the U. S. Other years are as follows: 1951 — 320,689 wells; 1952 — 332,058 wells, and in 1953 — 332,552 wells.

Of the total primary and secondary reserves of 7,714,410,000 bbl attributed to stripper wells, almost 4 billion bbl can be recovered only by use of secondary recovery methods. The total estimated liquid hydrocarbon reserves of the U. S. as of January 1, 1955, have been estimated to be approximately 35 billion bbl, so that the primary reserves of the stripper well fields represent slightly more than 10 per cent of the total U. S. reserves. Stripper secondary recovery reserves are approximately 11.5 per cent of the total U. S. secondary recovery reserves.

Estimate of primary reserves from stripper well fields in general includes the additional oil which it is estimated will be recovered under primary methods of production from the fields classified as stripper well fields. In the states of Illinois, Kansas, Oklahoma, Pennsylvania and in Texas, the primary reserves represent the oil to be recovered by present methods of operation and include secondary recovery reserves of projects now in operation.

The estimated probable secondary recovery reserves from stripper well fields are the additional reserves over and above primary recovery that could be recovered from these fields by the application of fluid injection methods. In New Mexico, this includes the total recovery from the fields that are predominantly stripper well fields; and

TABLE 1. National stripper well survey January 1, 1955.

State	No. of stripper wells	Production from stripper wells (barrels)	Abandonments	Average per well bbl/day	Acres	Total production	Primary reserves	Secondary reserves	Total primary and secondary reserves
						(thousands of barrels)			
Arkansas	2,919	11,753,898	112	11.03	62,866	29,124	111,143	32,601	143,754
California	12,836	48,343,000	137	10.32	118,823	355,865	632,901	528,850	1,161,751
Colorado	181	538,918	35	8.16	11,620	46,162	36,026	—	36,026
Illinois	25,692	71,365,000	468	7.61	494,480	71,365	695,849	@	695,849
Indiana	4,504	10,510,381	215	6.39	62,020	10,923	57,355	27,450	84,805
Kansas	23,733	41,730,036	972	4.82	624,370	118,309	229,025	181,025	410,050
Kentucky	16,233	4,500,000	250	.76	74,000	13,910	43,000	50,000	93,000
Louisiana	6,103	12,567,526	281	5.41	76,235	228,550	94,830	43,000	137,830
Michigan	4,169	12,043,558	147	7.91	135,420	12,043	60,762	10,800	71,562
Mississippi	207	583,885	5	7.73	8,210	34,238	2,291	—	2,291
Missouri	120	96,021	—	2.19	600	96	750	—	750
Montana	3,022	4,650,250	19	4.22	41,980	14,032	19,207	63,825	83,032
Nebraska	71	211,439	2	8.16	1,400	8,177	1,700	—	1,700
New Mexico	2,755	4,875,438	7	4.85	111,594	74,700	43,480	65,800	109,280
New York	24,200	3,274,000	NK	.37	82,363	3,274	29,000	62,200	91,200
North Dakota	7	14,845	—	5.81	280	6,232	—	—	—
Ohio	14,613	3,887,000	1,342	.73	118,000	3,887	36,772	7,000	43,772
Oklahoma	54,200	83,726,134	832	4.23	841,560	183,614	542,670	1,123,545	1,666,215
Pennsylvania	72,862	9,608,269	4,433	.36	635,211	9,608	32,000	418,587	451,587
Tennessee	36	12,800	—	1.35	185	13	—	—	—
Texas total	55,590	97,599,326	1,984	4.81	790,929	951,845	981,725	1,199,304	2,181,029
North Texas	19,221	19,251,195	712	2.75	243,010	70,109	364,600	739,000	1,103,600
West Central Texas	7,511	7,924,790	320	2.56	30,044	47,169	60,088	105,154	165,242
Texas, other	28,858	71,323,341	952	6.77	517,875	834,567	557,037	355,150	912,187
Utah	13	7,996	—	1.65	260	2,222	—	—	—
Virginia	12	5,936	—	1.36	100	0	—	—	—
West Virginia	12,964	2,900,000	164	.62	209,360	2,900	40,594	52,340	92,934
Wyoming	3,334	7,690,240	13	6.32	48,122	93,871	34,408	131,250	165,658
Other	—	—	—	—	—	2,129	335#	—	335#
Total stripper wells	340,276	432,495,896	11,318	3.48	4,509,988	2,277,095	3,726,833	3,987,877	7,714,410

@Primary reserve estimates include secondary recovery reserves of projects now in operation.
#Primary reserves stripper wells in North Dakota, Tennessee, Utah, and Virginia.

in the states of Kansas, Oklahoma, Pennsylvania, Texas and others, it represents an estimate of the additional oil which it is believed can be recovered from fields that have possibilities for additional recovery by the use of fluid injection methods. In Illinois, no estimate has been made for this figure.

Production from stripper well fields in 1954 was almost 50,000,00 bbl in excess of that produced in 1953. Approximately 20,000,000 bbl of this can be accounted for through increase in production from water-flood operations, and perhaps some additional through gas injection. The remaining is attributed to the increase in number of wells, now numbering 340,276 or approximately 68 per cent of all the wells in the U. S. The total amount of water-flood production in the U. S. during 1954 is estimated to be 118,000,000 bbl, the major portion of which is produced from fields classified as stripper well fields. In addition, an estimated 20,000,000 bbl of oil are being produced annually from secondary recovery gas drives in such fields, or a total of 138,000,000 bbl produced annually from secondary recovery operations principally from stripper well fields.

In a recent presentation of the secondary recovery reserves of the nation (P. E. February, 1956, pg B-116), Paul D. Torrey has compiled estimates that have indicated a secondary recovery reserve for the U. S. of 11,527,000,000 bbl. The secondary recovery reserves of the stripper wells represent almost 35 per cent of the total secondary recovery reserves in this country.

What is a stripper well? The number of stripper wells indicated is the number of wells in fields that are averaging less than 10 bbl per day per well, so, in some instances, where the individual well production is known, it includes only those wells making less than this amount. In addition, in fields that were classified as stripper, but because of secondary recovery operations are now producing in excess of 10 bbl per well per day, these fields have continued to be considered as stripper well fields. In a few states where marginal or stripper wells are defined by law, it includes all of these wells with the exception of a few instances where a very minor portion of the field has wells so classified. In a few instances, wells were classified as stripper wells because they were producing excessive quantities of water or small quantities of oil relative to the depth from which oil must be lifted.

Data presented in the National Stripper Well Survey as of January 1, 1955, represent a compilation of information from various contributors in the oil-producing states of the U. S. ★ ★ ★

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SUBMERSIBLE DRILLING BARGES
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Planning for . . .

FIRE PREVENTION On a Drilling Rig

Best way to fight a fire is before it starts. Here are some practical ideas that can prevent rig fires.

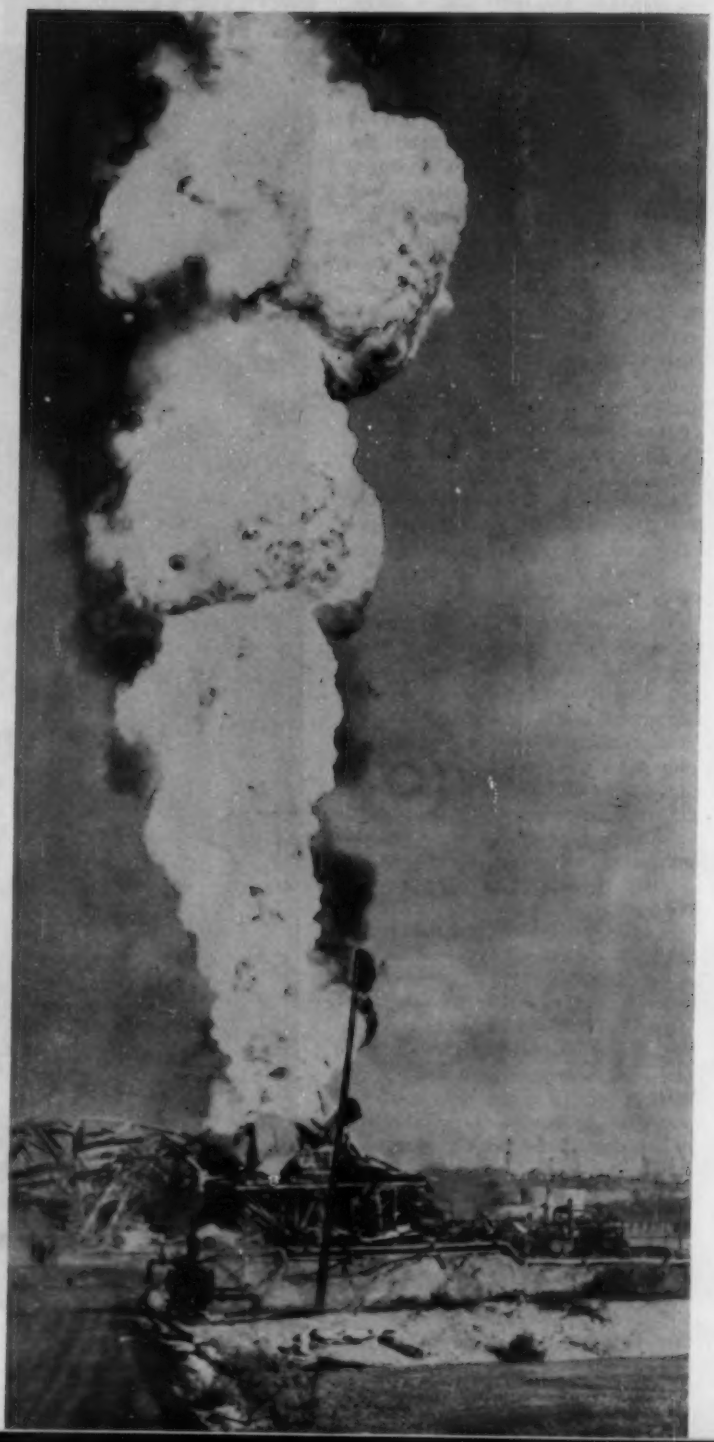
L. C. Horn
The Republic Supply Company of California, Los Angeles, California

THREE ingredients must be present to make and sustain a fire. They are: (1) Combustible materials in gas, vapor, or solid form, (2) oxygen in sufficient quantity to sustain combustion and (3) enough heat to ignite any fuels and start the chain of combustion. In the absence of any one of these factors, a fire cannot start.

From this, it seems to follow that the simplest and surest way to plan for fire prevention on a drilling rig would be to keep the first three ingredients from ever being present in the same locality at the same time. This reasoning also seems to sustain the adage that an ounce of prevention is worth a pound of cure, and the time to fight fires is before they start. The following are a few of the most essential preventive measures.

1. *No Smoking:* Smoking on a drilling rig floor, or around the mud tank, if using an oil-base mud, near the ditches, or inside the substructure is against the rules of almost everywhere; but smoking occurs and so do fires. This precaution, therefore, requires no discussion. Enforcing the rule is a quick way to remove one of the greatest fire hazards and cut down the possibility of fire by an important percentage.

2. *Good Housekeeping:* This seems like a trite item to list as a fire prevention measure, but it relates directly to the first premise that fire cannot occur where combustible materials are not allowed to combine with oxygen under conditions where sufficient heat may be present to ignite them. It should, there-



Rig totally destroyed by fire that started from welding torch upwind of the rig floor. Escaping gas from well was ignited and set the rig aflame.

fore, be a rule of the management that a clean-up on the rig should be a continuous process, and that crew members should be definitely trained to observe such procedures as part of an overall system of fire prevention and fire fighting. Oil from engines or any other source should be cleaned up immediately or covered with dirt. Other combustible or inflammable materials should be constantly guarded against any source of heat that might ignite them.

3. *Electric Wiring:* The sparks from a short circuit in electric wiring could ignite an inflammable gas or vapor and is many times the cause of drilling rig fires. Every precaution should, therefore, be taken, both in installing electrical wiring and by periodic inspection to be sure that the insulation on wiring remains intact. A heavy object falling on an extension cord can sometimes abrade the insulation and cause a spark, or a makeshift attachment for wiring strung around the rig may be such that the vibration of the derrick could wear the insulation and permit arcing between the wire and the steel structure. The best practice is to have all wiring in conduit and use extension cords only in emergency and with caution.

4. *Electric Generators:* Where electric generator plants are used, they should be located at a safe distance from the rig. At no time should this type of equipment be installed beneath the rig. Gas is likely to be present, and sparking of the brushes could ignite any gas or inflammable vapor present.

5. *Heating Devices:* These should never be of an open-flame type under any circumstances. In cold weather, a black-light electric heater and infrared lights should be substituted as sources of heat for the driller and the derrickman. The risk is too great otherwise.

6. *Welding and Cutting:* One of the greatest fire hazards in drilling is to have a welding or cutting job done while drilling is going on. Before starting, every precaution should be taken to be sure that no gas is present nor will be during the operation. A gas test should be made with a J. W. Gas Indicator, or comparably reliable equipment, and all crew members should be warned against opening any lines during the operation that might allow inflammable gas or volatile materials to escape.

All oil-soaked ground near the hot area should be covered with fresh dirt. Finally, all welding should be done on the windward side of the derrick, since there may be enough fumes from volatile liquids or free gas escaping to ignite. If the welder is on the lee side, the flame will then have to travel back to the source. By the same reasoning, all hot equipment should be kept parallel to the prevailing wind to prevent the possibility of fire being carried from one piece to another. These are all general precautions; each specific case requires inspection and good judgment to determine the safety measures to be adopted.

7. *Blowout Preventer Tests:* The blowout preventer, which is an essential piece of equipment in preventing fires, could fail on occasion like any other mechanical device, and the consequences might be serious. A regular procedure for testing this equipment at least once in 24 hr, therefore, should be adopted and a record of tests made part of the driller's report.

8. *Fuel Lines:* Whenever butane, diesel fuel, or dry gas is used, the transfer lines from the storage tank should be piping with a minimum of flexible metal hose where needed. The hazard where there is a possibility of heavy equipment driving over rubber hose or some heavy object rupturing the line, is too great a fire risk to be tolerated.

Throughout the oil world there are thousands of Roper Series F Pumps on the job. Big reason is *dependability*. Other reasons include: smooth, non-pulsating flow . . . equal size gears running in axial hydraulic balance . . . positive displacement requiring no priming . . . and importantly, four-port design. This latter feature of the Roper Series F Pump allows greater flexibility of installation . . . cuts installation time and costs. Four-port design, you see, permits 8 optional piping arrangements — 4 for CW and 4 for CCW operation. There are other Ropers in the line . . . in the pumping range and pressure range you require. Ask your distributor for all the facts . . . he'll show you how Roper can give you better service and higher efficiency in field storage, gathering line, and tank truck installations.

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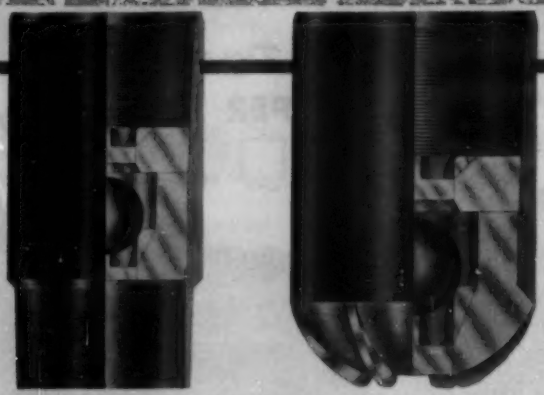

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• These new Rector Type "A" cementing shoes and collars have internal parts of a special aluminum alloy that combines strength, abrasion resistance and drillability. The bodies are precision machined from high quality seamless steel—internal aluminum alloy parts are machined and ground to close tolerances.

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REPRESENTATIVES IN ALL ACTIVE FIELDS

RECTORHEAD RECTORSEAL

These are the most obvious precautions to be taken in order to fight fire before it begins; but when it does, it should be remembered that the first 5 min are more important than the next 3 hr. Each crew should be trained to act instantly and according to pre-arranged procedure whenever a fire starts, because in the early stages, the fire can usually be quelled before it does any serious damage.

Every available extinguishing agent should be brought to bear on the blaze and simultaneously from every possible angle and aiming at the base of the fire. To insure the workability of the apparatus, inspections of extinguishers should be made at regular intervals not only to make certain that they are in working order, but that they are fully loaded and have a reserve supply of reloads so located as to be instantly available. This will also acquaint the men with the location of such equipment.

Fire Fighting Materials

Fire fighting materials have two types of action in controlling or extinguishing a fire — namely, cooling or reducing the temperature to the point where combustion is decreased, and smothering, where a gaseous extinguishing agent is used to reduce the oxygen content of the surrounding air to the point where combustion ceases.

The mediums most used to combat fires are water, in the form of fog, foam, or liquid; dry chemicals with a base of sodium bicarbonate; carbon dioxide gas and nitrogen gas; and sometimes drilling mud without an oil base.

Water. Water is the best and cheapest extinguishing agent that can be used in fighting the majority of fires, but on a drilling rig, even when it is in plentiful supply . . . and it is frequently not . . . it has a serious disadvantage. Water requires piping as well as a pumping unit, and since a drilling rig is bound to be moved frequently, the cost of moving the piping system with the rig is usually too costly.

Foam. There are two types of foam for fire-fighting — mechanical and chemical foam. The mechanical foam is produced by the action of a chemical detergent or protein-base foam, mixed with water and then aspirated through a certain-type nozzle.

One example is a special device that mixes a foam-producing chemical with water mechanically in just the right proportions regardless of pressure or rate of flow.

The chemical foams, on the other hand, are produced by the reaction of two chemical substances, such as an acid and an alkali, which foam when mixed. They form bubbles that smother

the fire while the water content helps to cool it.

Water Fog. Water fog is produced by a type of nozzle that causes two high-velocity streams of water to impinge upon each other and break up the water into fine droplets. This multiplies the surface area of the available water and increases the cooling power in the same proportion when it contacts the fire.

Dry Chemical Medium. The base of dry chemicals used in fire-fighting is usually sodium bicarbonate, the substance that we recognize as common baking soda. It not only requires air, or a gas under pressure, to expel it through a nozzle, but since it attracts moisture from the air and has a tendency to cake in damp weather, manufacturers coat each crystal with a water repellant, such as aluminum stearate. This produces a powder of such non-cohesive quality that it will flow across a flat surface like water. It is easily expelled through a nozzle and can be sprayed upon a fire where the heat liberates carbon dioxide from the chemical to serve as an added extinguishing agent.

Carbon Dioxide and Nitrogen Gas. These are non-combustible gases, which are used to dilute or exclude air and make combustion difficult or impossible. CO_2 is bottled in cylinders under extreme pressure, which converts it to a liquid. When the extinguisher is discharged into the atmosphere, it immediately returns to its natural state — gas. This excludes oxygen, and the fire is thus extinguished. This type of extinguisher is very clean and leaves little or no trace. Its only disadvantage is that gas will drift with prevailing wind and can be carried away from the fire.

Drilling Mud. Drilling mud that does not have an oil base can be used with a proper nozzle to some advantage in fire fighting. It has a good blanketing effect on a fire and acts as a cooling agent as well. In locations where water is scarce, it makes a good reserve material for fire fighting. A 1-in. high-pressure hose with a ¾ or a ⅝-in. nozzle tip connected to the mud pumps is all that is needed to make the material ready for use.

Types of Fires

There are four general types of fires that are likely to occur on a drilling rig. To cope with some of these fires special materials are required. These types are as follows:

1. **Still fires,** which include oil-base, mud-tank fires, cellar fires, etc. are a quiescent type that do not flow.
2. **Flowing fires** from causes like well blowouts, oil line ruptures,

RECTOR TYPE "R"
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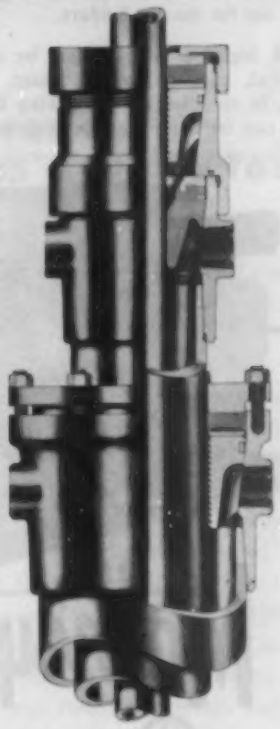
GIVE YOU MAXIMUM VALUE IN EVERY RESPECT



• Designed for pressures up to 2,000 lbs., Type "R" Casing and Tubing Heads have many features and advantages that make them outstanding values in heads of this type. Extremely adaptable, they are ideally suited for the widest possible range of producing conditions. Ask your Rector Representative or SUPPLY STORE about Type "R" Casing and Tubing Heads for your low-pressure wells, or to replace high-pressure tubing head and tree when changing from flowing to pumping conditions.

SEAL
Both casing and tubing heads have an oil-resistant pack-off which is forced into sealing position by a split packing gland. Casing Head gland is tightened down by 6 stud bolts . . . Tubing Head gland by a cap threaded to the body.

SUSPENSION
Casing Head has case-hardened, three-segment type HINGED slips of ribbed construction to allow full flow to outlets. Tubing Heads employ some type of suspension or special threaded type or slip-type mandrel hanger for use with Kobe pump.

SIDE OUTLETS
Both Casing and Tubing Heads are available with 2", 2½" or 3" threaded side outlets.

BOTTOM CONNECTIONS - SIZES
Casing Heads have male or female threaded bottom connection sizes 8⅝" through 13⅜". Tubing Heads available with male or female threaded bottom, 5½" through 7", also all flange sizes and series, with standard API ring groove and bolting arrangement.

STRIPPER
When desired, a slip bowl adapter carrying slips, packing and gland can be attached to the threaded top of tubing head body. Strippers and slips are interchangeable.

For complete description and illustrations of various assemblies, see pages 4230-34 of 1954-55 Composite Catalog.

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REPRESENTATIVES IN ALL ACTIVE FIELDS
RECTORHEAD RECTORSEAL

and the like, where the burning material may spread.

3. **Vapor fires** include dry gas, butane, and other volatile materials, which retain their bases at the source of the burning material.

4. **Electrical equipment fires** involving live equipment, where the use of water, which is an electrical conductor, might be dangerous for the fire fighters.

Still fires are best handled by dry chemical, carbon dioxide, water, or foam. In the case of the flowing fire, there can be complications that must be handled according to its particular individual condition. Water fog in sufficient quantity will help to cool the fire and control it, while efforts are made to starve the flame by shutting off the source of fuel. If this is not immediately possible, dry chemical, combined with fog, makes an extremely desirable extinguishing agent. Slope of the ground should be considered and dikes thrown up as soon as possible, to prevent the fuel spreading. Water fog applied on the burning surface of heavy crude oil will cause a frothing action, which helps to smother the fire.

Vapor fires are not usually extinguished unless it is possible to shut off the source of supply. A fog curtain can be used to get to the source with great advantage. It can sometimes be done by hitting the flame hard with a dry-chemical extinguishing agent or high-pressure water fog streams, but consideration should first be given to the contamination of the air with an explosive gas or vapor that may follow.

Electrical equipment involved in a fire poses the problem of the danger of electrical shock or electrocution for the operators if water in straight stream at low pressure is played upon a source of high voltages. It is possible for the current to leap through the stream to the nozzle and ground through the feet of the firemen with disastrous results.

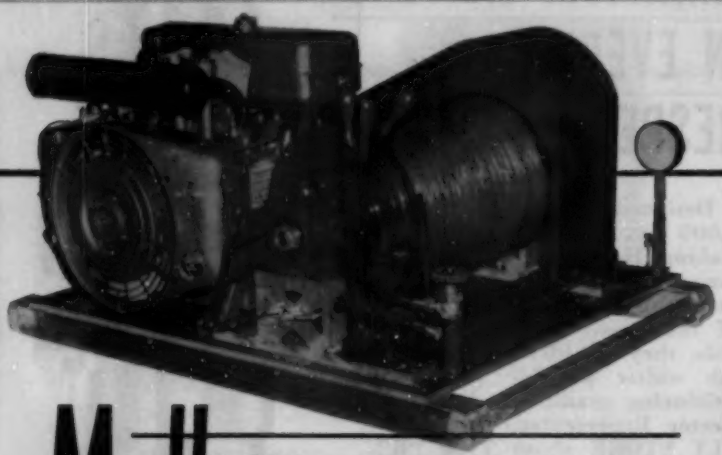
If fog is used on electrical fires, it is much less dangerous. The best practice in the case of this type fire is to protect the surrounding equipment with water until a qualified electrician or professional fireman can take over. If the power switch can be pulled without stopping the pumps, it will remove the danger so that any material can be used to fight the blaze.

Best fire fighting materials for most oil well drilling rig fires are fog and dry chemical.

The dry chemical extinguisher comes in various sizes, namely 4, 20, 30 and 150-lb and larger units. This extinguishing agent is energized by carbon dioxide or nitrogen in cylinders. In each case, they are used for dispensing the dry chemical under extremely high pressure in large quantities. The powder is finely ground and envelops the entire area of fire so completely that it actually separates heat and flame from unburned gases. In the large dry chemical units, nitrogen is the best expelling agent since it does not change with temperature as in the case of CO_2. Nitrogen gas allows the powder to stay free of moisture and avoids caking.

These units can be changed quickly and are insurance against running out of materials for any ordinary fire. They can be recharged immediately at the scene of the fire. The 150-lb type must, of course, be mounted on wheels and is usually a reserve unit for fighting fires too large for the smaller hand-portable units. This unit is equipped with a 50-ft discharge hose and nozzle that is ample for reaching all parts of the rig.

It is well to remember that each extinguishing agent has its advantage and disadvantage as to efficiency, depending upon the type of fire to be extinguished. For example, large areas of oil must be covered with fog or foam and the flames reduced in area so that extinguishment can be accomplished. In large fires (oil), foam is the better extinguishing agent.



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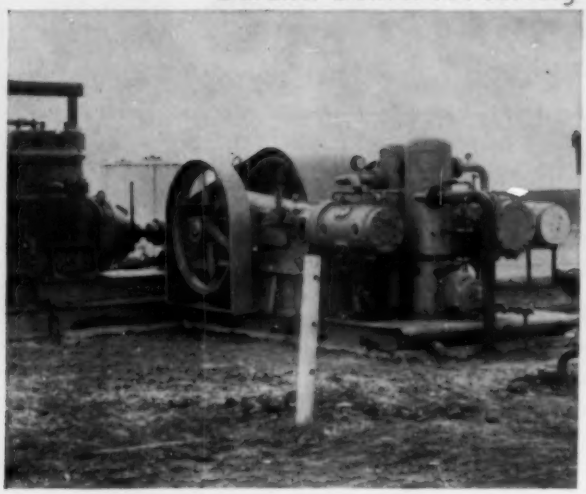

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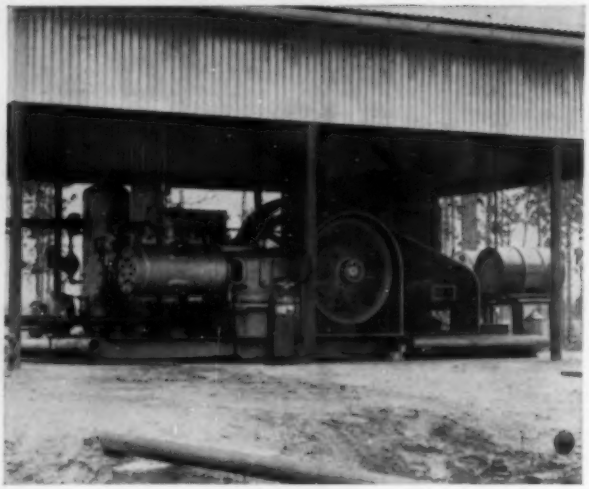
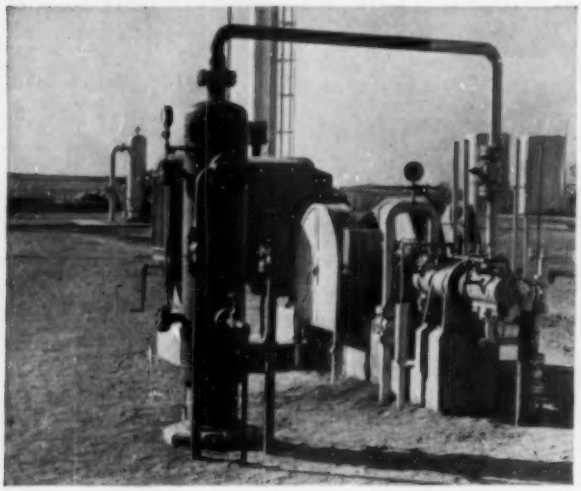
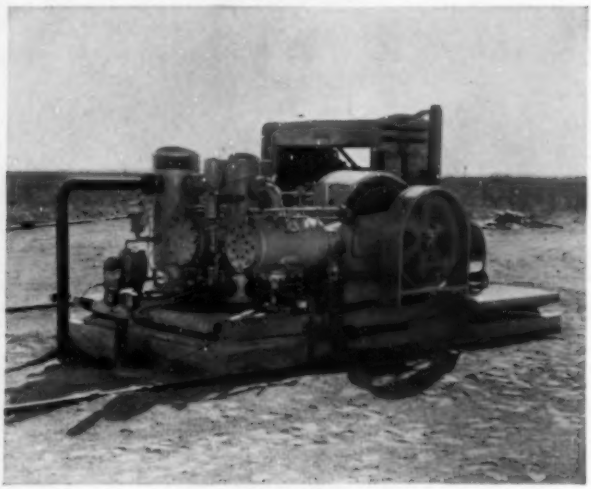


Bucking line pressure



Field processing



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Dry chemical when applied to fire (oil or gas) in sufficient quantities is also extremely effective. The only shortcoming of dry chemical extinguishers is that they have very little cooling action and a fire must be extinguished shortly after it starts; otherwise, metals are likely to become extremely hot as well as combustible materials, such as wood, etc., in which case re-ignition could occur.

Location of Equipment

Proper location of equipment is an important factor in the control of drilling rig fires and should be studied in every case to determine the reactions of the crew when a fire starts and to locate the equipment so that fire fighting units will be instantly available even when the crew is forced to retreat from the derrick floor. Specifically, portable extinguisher units should be hung in an accessible place at the head and foot of stairways, since the natural reaction of the crew is to run for the exits when a fire starts. Two units should also be hung near the drawworks for instant use by the driller or any other member of the crew. Above all, every crew should be given rigid training so that it has a plan of action when a fire occurs and can fight it as a team. Such training, in turn, may help to make each individual conscious of the dangers from fire, and the fire fighting can be done the best and least expensive way — namely by fighting them before they start. ★ ★ ★

SEPM Lists Best Papers

Recipients of the awards for the best paper in the **Journal of Paleontology** and in the **Journal of Sedimentary Petrology** for 1954 have been announced by Francis J. Pettijohn, president of the Society of Economic Paleontologists and Mineralogists.

Donald Parkinson, Birmingham, England, will receive the award for his paper entitled, "Quantitative Studies of Brachiopods from the Lower Carboniferous Reef Limestones of England," published in the society's bi-monthly **Journal of Paleontology,** Volume 28, Number 3 (May, 1954).

Harold N. Fisk, Humble Oil and Refining Company, Houston, Texas, Charles R. Kolb, Waterways Experimental Station, Vicksburg, Mississippi, Edward McFarlan, Jr., Humble Oil and Refining Company, Houston, Texas, and Louis J. Wilbert, Jr. (deceased) will receive the award for their paper entitled, "Sedimentary Framework of the Modern Mississippi Delta," published in the society's quarterly **Journal of Sedimentary Petrology,** Volume 24, Number 2 (June, 1954).

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You can retard mechanical wear, corrosion and erosion with Ampco polished rod liners. Even in many of the toughest oil-well services, you can get four times longer life with these remarkable wear-resistant liners—made from Ampco Metal.

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Powerful tug "Grampus" Launched for offshore work

One of the most powerful tug boats in the offshore fleet, the G & H Towing Company's "Grampus" packs a 1700-hp wallop in its 105-ft steel hull. With a beam of 27 ft and a draft of 14 ft when fully loaded, it is capable of heavy-duty towing operations to any part of the world. It was recently commissioned at San Jacinto Battleground near Houston, Texas, the company's headquarters.

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PROVIDES 6 different sized choke inserts which are individually positioned in the line of flow by a fractional turn of the orifice-carrying disc . . . under constant flow and high pressure.

The 6 graduated orifices are changed to a new range in minutes...without shutting-in the well.

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An entire lease is controlled accurately and precisely in minutes through this battery of Willis Rotary Adjustable Chokes.

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Four Oilmen Honored At Kansas API Meet

Four prominent oil men have been honored with the American Petroleum Institute's "Citation for Service" award at a special banquet during the API's annual meeting of the Mid-Continent district of the division of production.

Recipients of the awards were Howard G. Texter, Spang-Chalfant division of National Supply Company, Tulsa; John E. Eckel, The Carter Oil Company, Tulsa; George Berlin, Skelly Oil Company, Velma, Oklahoma; and Clayton Husted, Clayton Husted Contractors, Pampa, Texas.

The awards, which are acknowledgement of outstanding individual service to the oil and gas industry through the API, were presented at a dinner at the Broadview Hotel by A. W. Thompson, of A. W. Thompson, Inc., Houston, who is vice president for Production of the American Petroleum Institute.

Texter received the award for outstanding service as a member of the standardization committees on rotary equipment and tubular goods since 1947. He was cited for his authoritative knowledge and cooperative spirit, which greatly facilitated the work of the committees.

Eckel's award was made on the basis of outstanding service as chairman of the Mid-Continent district study committee on completion practices. His leadership and professional knowledge were instrumental in publication of a valuable API monograph on the subject.

Berlin was awarded the citation as a result of his outstanding service in Mid-Continent district activities of the API. He served as chairman of the division of production of the Mid-Continent district in 1941.

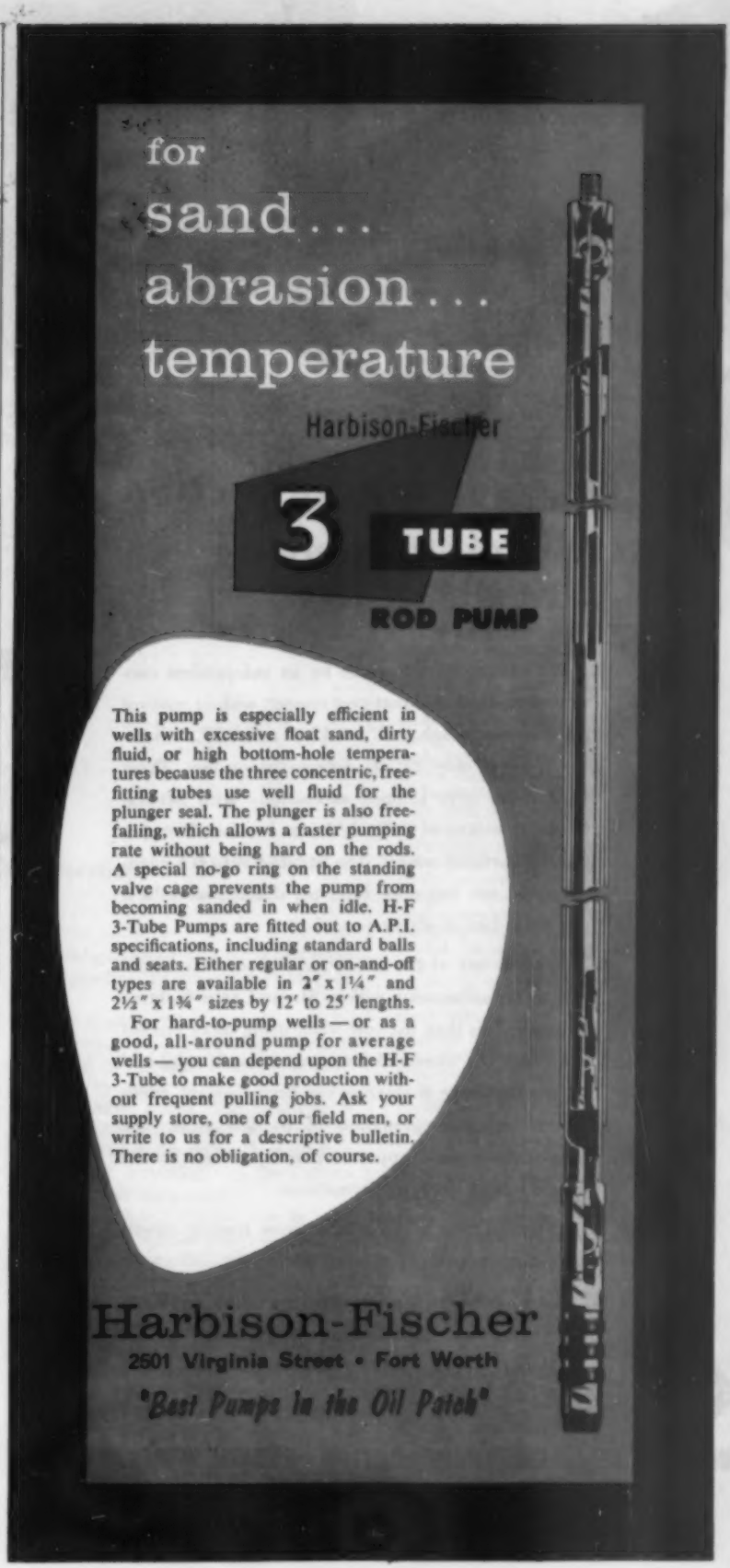
Husted was cited for his outstanding service in 1955 as secretary-treasurer of the API Mid-Continent district, division of production.

IDEA!

The oil industry continues to stay on the defensive as one state after another raises gasoline taxes and the Federal government holds the 2 cents a gallon tax.

Instead of asking for mercy, why not a more intense offensive by oil companies to have gasoline and lubricant sales taxes spent for highways only? A good portion of oil products taxes are spent for other purposes. Right now direct and indirect taxes on gasoline are more than its actual cost.

If the 2-cent Federal tax were relinquished in favor of states, there would be less money spent for administration.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ROD PUMP
This pump is especially efficient in wells with excessive float sand, dirty fluid, or high bottom-hole temperatures because the three concentric, free-fitting tubes use well fluid for the plunger seal. The plunger is also free-falling, which allows a faster pumping rate without being hard on the rods. A special no-go ring on the standing valve cage prevents the pump from becoming sanded in when idle. H-F 3-Tube Pumps are fitted out to A.P.I. specifications, including standard balls and seats. Either regular or on-and-off types are available in 2" x 1¼" and 2½" x 1¾" sizes by 12' to 25' lengths.
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Here's the Proof:

In laboratory tests made by an independent consultant, it was found that neat cement, with or without gel, flowed through both a 0.125" and 0.172" diameter hole at only 25 psi differential or less. These same holes were bridged successfully with **Strata-Crete 6** mixes of 1/3, 1/2, or 1 cubic foot per sack of Portland cement. The **Strata-Crete 6** bridges withstood not *less* than 1600 psi differential with a minimum loss of slurry.

This is one of the important reasons why actual cost to fill an annulus with a **Strata-Crete 6** slurry is usually less than the cost when using other cement mixtures. The increased bridging strength exhibited by **Strata-Crete 6** slurries has been brought about by an improved gradation of particle sizes. The improved bridging properties plus lightweight results in less loss of slurry to formations.

Strata-Crete 6 is available from leading oilwell cementing service companies.

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Louisiana Looking for New Allowable Formula

Louisiana's Department of Conservation is looking for a new method by which to base its well allowable for oil production. The current formula, mainly based on well depth, is causing more oil to be produced than market demand. As new wells are completed, the over-production grows. With growing concern over the situation, Commissioner John B. Hussey invited operators help. He asked for the formation of an "Industry Allowable Committee" to study the problem and make recommendations to the Commission for a new allowable formula which would distribute the necessary cutback equitably.

Louisiana's allowable problem stems from its rapid increase in new oil wells. Last year, it was reported, new wells accounted for an estimated 125,000 bbl per day new oil production. Offshore production grew from 40,000 bbl daily to nearly 100,000 bbl per day in little over a year. The problem is not to cut total oil production, but to adjust the per-well output in order to make room in the demand picture for new wells.

Current depth-bracket basis allows 37 bbl/day for wells from 0-2000 ft deep; 110 bbl/day for wells from 8-9000 ft; and 305 bbl/day for wells over 16,000 ft deep. These figures are for onshore wells; offshore wells are higher. For example, an offshore well from 8-9000 ft deep has an allowable of 214 bbl/day, nearly twice that of onshore wells. This depth formula was originally based on well costs: the deeper the well, the greater the costs, and therefore, the operator is entitled to bigger allowables.

At the preliminary meeting recently of the industry group, there was some favor to retaining the present allowable formula, but establishing producing days. An "across-the-board" reduction was discussed, but no definite plan was made. It will take time, study and compromise, but, all fingers point to a change in Louisiana's allowable picture.

Southern Area API Officers Elected

New officers of the Southwestern District of the American Petroleum Institute division of production were named at the closing session of a three-day technical meeting here recently.

Midland oilman P. E. Fletcher, in charge of producing operations in West Texas and New Mexico for Atlantic Refining Company, was elected district chairman to replace Alden S. Donnelly.

John Younger, The Western Company, Midland, was made secretary-treasurer.

Mammoth rubber tire tank that rolls as a wheel can be towed to inaccessible areas and serves as storage for a variety of liquids.

P 581.6

A New Idea In Transportation

The Rolling Fuel TanK

Is this an answer to the fuel transport and storage problem in drilling and exploration?

A NEW watermelon-shaped collapsible fuel tank has been developed by Goodyear Tire and Rubber Company of Akron, Ohio, to be towed over any kind of road, soft or rocky terrain by any vehicle capable of pulling a trailer. Although its application in exploration and drilling operations has not been fully determined, this new mobile storage tank does offer some possibilities. Fuel, water and some chemicals can be transported to remote locations not easy accessible by tank trucks and trailers. At the location, the rolling tank serves as storage. When less than full, either air or gas fill out the rubberized tank so it can be towed where needed. When containing fuel, it will float in water. Bearing pressure on soil is relatively low. It is possible to tow it over marshes, rocky or level terrain, or even tow it with a boat.

The standard unit has a capacity of about 250 gal, although special units can be made to hold up to 2000 gal. These rolling tanks may be towed singly or in "trains" of up to five units. Equipped with brakes, the standard unit weighs about 400 lb. When filled with gasoline, its gross weight is 1900 lb.

The tank is filled and drained by means of a quick disconnect fitting at one end of the axle. Filling is accomplished by either a hand or powered displacement pump. The tank-tire is evacuated and collapsed before filling. It is inflated while filling. If desirable, filling and emptying can be accomplished while underway.

These rolling tire-tanks can be used to transport liquids over all types of roads, for moving fuel over terrain impassable to conventional vehicles, for range extension of track vehicles moving over soft or rough terrain; and for use as fuel storage and transportation in support of helicopter or small reconnaissance plane operations.

Liquids that safely can be transported include: (1) Any fuel up to 40 per cent aromatic content; (2) diesel fuel; (3) white gasoline; (4) liquid caustic soda; (5) either sodium hydroxide or potassium hydroxide and (6) dilute phosphoric acid. ★ ★ ★

THE BEST WAY TO LOWER OPERATING COSTS.... LOWER A REDA PUMP INTO YOUR WELL

With investment and labor costs continuing to increase, economy of operation is of paramount importance in producing wells with decreasing oil-water ratios.

Reda-Submergible Pumps are an economical means of producing wells with high fluid volume. Over 80 million barrels of oil have been produced to date from wells previously unprofitable to operate. Not only has production increased, but pumping with Reda extended the ultimate economic life of thousands of wells previously produced at low rates of fluid withdrawal.

Sizes are available to 300 h.p.; capacities from 20 bbls. to 25,000 bbls. per day; depths from 200-feet to over 10,000-feet. Easier, less expensive installation, low operating costs, increased production, greater operating life, and efficient performance lower costs when pumping with Reda.

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EXPLORATION ACTIVITIES

LOUISIANA

★ Phillips Petroleum Company found five promising oil and gas sands in its No. A-1 Eugene well now drilling on a wholly owned 3825-acre Federal lease in Block 129-A, Eugene Island area, 40 miles off St. Mary Parish, in the Gulf of Mexico. Two new sands with 51 ft of pay were encountered between 10,839-11,109 ft, and appear to be the same as the upper productive formations of the Block 128 field immediately to the north. The well previously had found 96 ft of oil and gas formations in three shallower zones between 8589-9395 ft. It will be drilled to a projected depth of 14,000 ft. The No. A-1 Eugene is 2½ miles northwest of the company's No. 1 Eugene, recently completed as an oil well on the same block. A third Phillips well one-half mile north of the No. 1 Eugene recently encountered a total of 178 ft of new oil and gas sands in eight zones between 4151-6504 ft.

★ An offshore wildcat drilled in Block 30 of the Ship Shoal area, off Terrebonne Parish, has been brought in as a gas-distillate discovery by Kerr-McGee Oil Industries, Inc. The well is State Lease 752 G-1 (OCS-0333 No. 2), drilled in about 18 ft of water, and located approximately nine miles from land. Kerr-McGee is the operator and contractor. Phillips Petroleum Company and Stanolind Oil & Gas Company own an interest in the well, drilled to a total depth of 11,950 ft and perforated between 11,534 and 11,555 ft.

The well was opened on drillstem test with full water cushion and ¼-in. top and bottom chokes. After unloading cushion the well tested at the rate of 1,388,000 cu ft of gas a day through a ⅛-in. choke with 4000 psi flowing tubing pressure, and 3,390,000 cu ft through a 13/64-in. choke with 3500 psi flowing tubing pressure. On both tests the well made ungaged amounts of distillate. The discovery well is on the north flank of the Block 32 Ship Shoal area salt dome, and marks the first gas production on this dome.

★ Monterey Oil Company and Kern County Land Company have completed a confirmation well in the important Intracoastal City gas and condensate field which they discovered late last year in Vermillion Parish. The well, Monterey et al., State No. 2, just completed, was drilled to 15,725 ft and was perforated between 13,670 and 13,710 ft, in the lowest of four productive sands that were penetrated. It flowed at a daily rate of 4,000,000 cu ft of gas and 204 bbl of 47.5 deg condensate through a 16/64-in. choke, with a pressure of 4325 psi on the tubing. The No. 2 well, located one-half mile northeast of the discovery well, confirmed a fault cut at 13,800 ft. This fault controls the northerly updip limits of the field and the productive gas condensate reservoirs occur on the southerly downdip side of this fault where 90 per cent of Monterey's acreage is located.

WYOMING

★ A confirmation of Nugget Sand production in the Crooks Gap field has been made by the Sinclair Oil and Gas No. 13 Crooks Gap Unit. Casing has been run at total depth of 5603 ft, following a one-hour drillstem test at 5585-600 ft. Recovery totaled 4280 ft of 42 deg oil and 370 ft of oil and gas cut mud. The Nuggett was established as the pay zone in this field last September by the same operator's No. 11 well, about one-half mile from the confirmation test. Previous production from this prolific pool had been from the Muddy and Lakota.

TEXAS

★ A significant Caddo lime discovery was made recently in Clay County by W. B. Omohundro, Wichita Falls. The operator's No. 1 W. G. Scaling flowed 210 bbl of 42 deg oil in 10 hours for a calculated daily potential of 504 bbl. Flow was through a 16/64-in. choke from perforations at 5536 to 5546 ft. The well was drilled to a total depth of 5694 ft. Gas-oil ratio was 1780 to 1. Omohundro's well is five miles east of Windthorst.

★ Sinclair Oil and Gas reports successful completion of its exploratory well, the No. 1 Kate C. McAdams, in Nolan County. The well flowed 304 bbl of 47.3 deg oil in 24 hours through a ¾-in. choke. Productive formation is the Ellenburger limestone, perforated at 6480-510 ft. The well is on the south edge of Sweetwater, about 6 miles from the nearest Ellenburger production.

★ Husky Oil Company has a new field discovery at its No. 1 Wimberly, on a state potential test, flowed 407.52 bbl of 28.6 deg oil in 24 hours on a ¼-in. choke. The Husky No. 1 Wimberly is in the northwest Seminole area in Gaines County. Husky Oil Company has 100 per cent working interest in the well and in a total of 840 acres in the area of the well.

★ Magnolia Petroleum Company has completed its No. 1 Morrison as an Ellenburger gas discovery in northwest Val Verde County. On potential test, the well flowed 1,182,000 cu ft of gas daily through perforations at 13,944-14,062 ft and from an open hole section at 14,168-14,940 ft. The Morrison was bottomed at 15,143 ft in the Wilberns sand of the Cambrian, and later plugged back to 14,940 ft for the Ellenburger completion. The discovery is 13 miles northeast of Pandale.

★ A new Strawn reef discovery has been completed in Irion County by British American Oil Producing Company and Atlantic Refining Company. A corrected potential of 207 bbl of oil per day through a 16/64-in. choke has been recorded on the well, the No. 1 Noelke, nearly 7 miles southwest of Mertzon on Tom Green County School Land survey. Gas flow on the corrected test was 349,000 cu ft daily. An earlier report showed a flow of 113 bbl of oil per day, from pay at 6898-6908 ft.

★ Superior Oil Company has been assured a flowing discovery from the McKee Sand at its No. 1-12-F University in the East Block 12 Ellenburger field of southwest Andrews County. The well, on section 26, block 12, University Land survey, flowed on drillstem test at 9818-9882 ft gaged 19 bbl of oil in 30 minutes after a 15-minute flow to the pits. Reversed out was 67 bbl of oil. A second test in the McKee at 9882-9912 ft, with tool open 86 minutes, showed gas in 13 minutes and mud in 57. After cleaning to pits 9 minutes it flowed 37 bbl of oil in one hour. The operators were last reported drilling ahead below 10,048 ft.

PORTUGAL

★ Mobil Exploration Portugal, Inc., a subsidiary of Mobil Overseas Oil Company, Inc., operating under an agreement with Companhia dos Petroleos de Portugal, has abandoned its second well, Arruda No. 1, located north of the town of Vila Franca de Xira some 48 km north of Lisbon. Drilling was stopped on March 20 at a total depth of 7009 ft. The first well, Pinhal Novo No. 1, located south of the Tejo River, was abandoned in rock salt at a depth of 5531 ft on August 5. The company is now setting up a new 12,000 ft rig at Barreiro No. 1 location, 10 km outside Lisbon just south of the Tejo River, and expects to spud the well within the next few days.

Pay out or play out?

The question is a matter of *recovery*, not discovery. You can't answer by simply shaking the package.

Logs, maps, and run tickets are not enough. Sooner or later, someone will ask for the *master key* — a fully comprehensive, reputable core analysis report. Whether the situation involves the sale, financing, or unitization of reserves, the presentation of these factual data on the formation's basic characteristics and future productive ability is a fundamental step in economics.

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Do You have a "Frac" Well that's tough to Pump?

THEN you should try a Pacific "OIL STATES" rod insert, bottom hole oil well pump...

WHY? because the "OIL STATES" is pumping some of the toughest, sandfrac wells in the Mid-Continent fields—from the extreme depths in West Texas and the gulf coast to the shallower zones in Oklahoma, Kansas and Illinois...

In well after well, oil operators report highly successful pumping with Pacific "Oil States," particularly after trying cup and ring pumps or metal-to-metal pumps with wide tolerances between plungers and tubes. The Pacific "Oil States" offers a new approach to pumping sandy or dirty oil wells. Specifically manufactured to a very close tolerance between plunger and liners, so as to eliminate sand passing between the sealing surfaces which normally cut and score plunger and liners. The Pacific "Oil States" is not merely a "clean-out" pump. It is engineered to pump sand with its "surging action" and further, to pump with a high efficiency made possible only by the close tolerance.

Check these features:

- Furnished with a tolerance between plunger and liners in fits as close as Minus ½ thousandth...
- Furnished in standard steel with stress-proof, heat treated fittings for normal sandy pumping...
- Furnished with stainless steel barrel and parts with "PACILITE" Hard Chrome Plunger for corrosive conditions...
- Furnished in "Stroke-Thru" design to eliminate sticking of plunger and liners in wells that deposit gyp or barium.
- Furnished in pump lengths from 4 feet to 20 feet, with a wide choice of arrangements of valves and fittings...
- Furnished in the following sizes and bores:
  1" and 1¼" for 2" tubing
  1½" and 1¾" for 2½" tubing
  2¼" for 3" tubing
- Plunger and Liners can be "Reground" several times to give the most economical repair costs...

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PACIFIC

DW-15

Exploration

OKLAHOMA

★ Parker Petroleum Company has opened a new gas pool in Beaver County, at its No. 1 Mitchell. The well tested at the rate of 9,000,000 cu ft of gas daily with distillate from the Upper Morrow sand, topped at 7631 ft. The 12-minute drillstem test at 7631-69 ft surfaced gas in 15 seconds. Maximum flowing pressure was 1885 psi and bottom hole pressure was 2270 psi. Parker will test the basal Morrow and Chester lime in the well. This is two miles south and one mile west of the Sleeper area.

★Shell Oil Company has completed its McLish discovery, the No. 1 Johnson in the Northeast Royal pool in Southwestern Garvin County. The well flowed from 41.3 deg oil perforations at 13,006-32 ft at the rate of 747 bbl per day. Gas-oil ratio was 921 to 1. Kidd Williams had contract on the producer, which plugged back from 14,261 ft and set the 5½-in. liner at 13,050 ft.

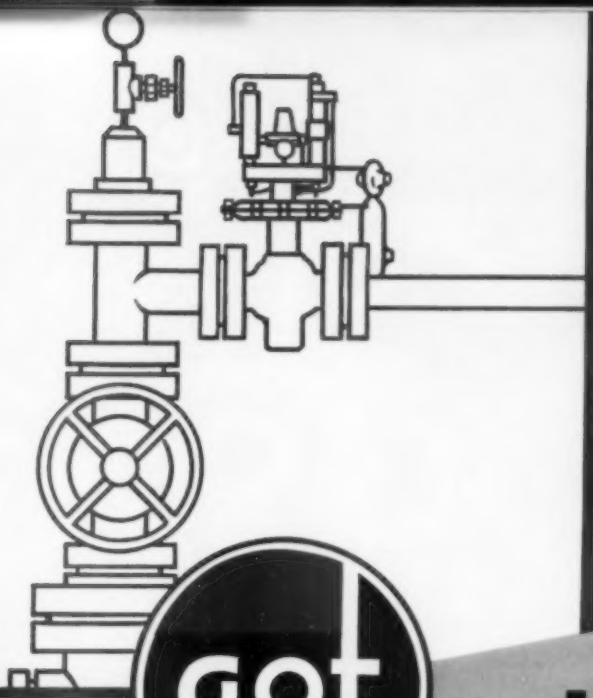
★ A McClain County wildcat, Gulf Oil's No. 1 Dyer, has indicated three promising pay zones in recent tests. The well, on drillstem test at 10,240-317 ft in the Second Bromide with 1240 ft water cushion, showed 6300 ft of gas in drill pipe. With tool open 1½ hours, 2040 ft of heavy oil and gas cut mud and water cushion and 930 ft of muddy salt water was recovered. Shows of oil were also tested in the First Bromide sand and the Hunton lime.

COSTA RICA

★ Union Oil Company of California has confirmed the rumored oil showings in their exploration well in the Central American Republic. The well encountered a substantial thickness of oil saturated limestone at approximately 5400 ft which yielded gas and high gravity oil on several formation tests. Casing has been run to protect the zone and the well is prospecting ahead. This is Union Oil's fourth test on their 3,000,000 acre exploratory concession in Eastern Costa Rica, the first three being inconclusive.

NEW MEXICO

★ J. C. Williamson, Midland, Texas, operator, has been assured prolific flowing production in the Devonian at his No. 1 Spencer in central Lea County. Drillstem test in the rank wildcat was run from 11,030 to 11,042 ft, resulting in an 80-bbl hourly oil flow. The test, now under completion, is about three miles south of the Lovington field. An earlier test in the Pennsylvanian recovered 4400 ft of free oil, and no water, with tool open two hours. On this test, at a depth of 9720 to 9781 ft, gas to surface time was five minutes.



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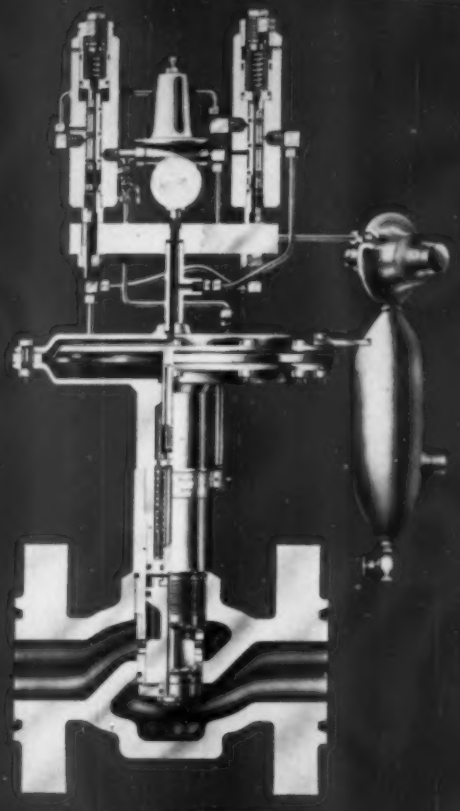

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How deep will drilling eventually go? No one knows. But in the future, as in the past, Schlumberger will have the equipment and techniques proved and ready to provide well services to any depth oil operators drill.

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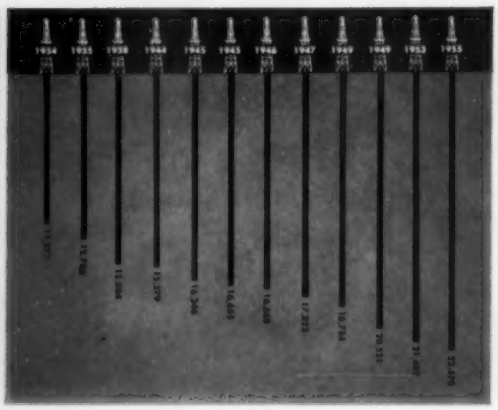

DRILLING DEPTH RECORDS

1934 – General Petroleum Corp.'s Berry 1, Belridge, Kern Co., Cal., 11,377 ft.

1935 – Gulf Oil's McElroy 103, Upton Co., West Texas, 12,786 ft.

1938 – Continental Oil's KCL A-2, Wasco, Kern Co., Cal., 15,004 ft.

1944 – Phillips Petroleum's Ada Price 1, Wildcat, Pecos Co., West Texas, 15,279 ft.

1944 – Standard of Cal.'s KCL 20-13, South Coles Levee, Kern Co., Cal., 16,246 ft.

1945 – Phillips' Schoops 3, Wildcat, Brazos Co., Gulf Coast Texas, 16,655 ft.

1946 – Pacific Western Oil's National Royalties 1, Miramonte Area, Kern Co., Cal., 16,668 ft.

1947 – Superior of Cal.'s Weller 51-11, Wildcat, Caddo Co., Okla., 17,823 ft.

1949 – Superior-Limoneira 1, Wildcat, Ventura Co., Cal., 18,734 ft.

1949 – Superior, Unit 1, Wildcat, Sublette Co., Wyo., 20,521 ft.

1953 – Ohio Oil's Kern Co. Lands "A", 72-A, Paloma field, Kern Co., Cal., 21,482 ft.

1956 – Richardson-Bass, John Mecom, Freeport Sulphur, 1 L Humble – L-L-8E – State Lease 2414, Plaquemines Parish, La., 22,570 ft.

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— State Lease 2414, Plaquemines Parish, La., 22,570 ft.

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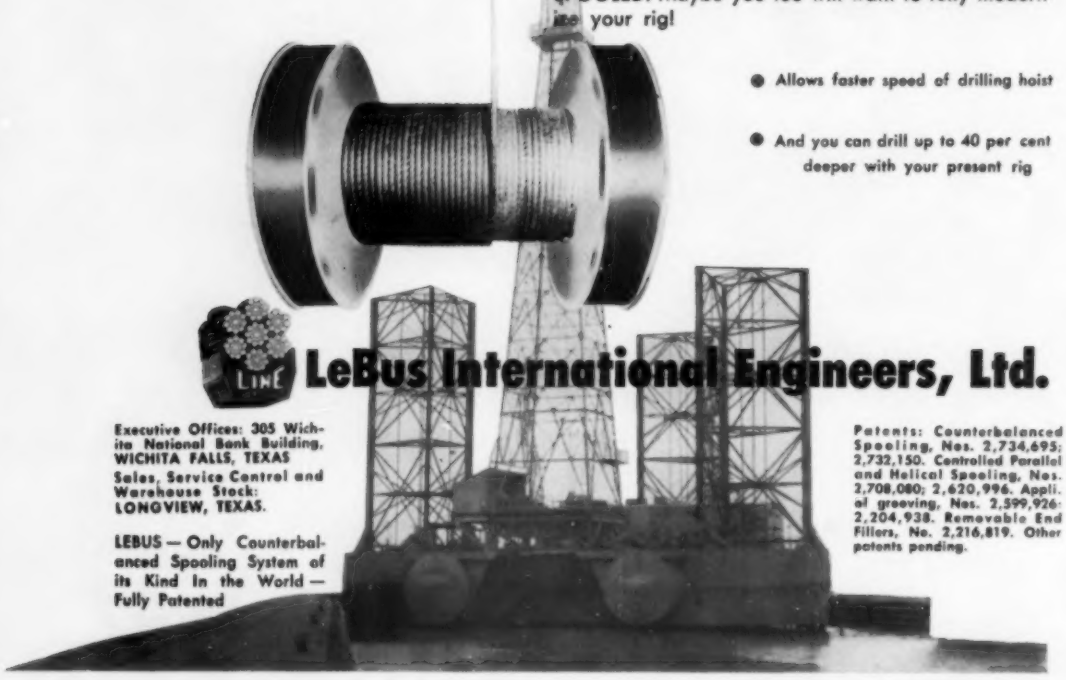

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Patents: Counterbalanced Spooling, Nos. 2,734,695; 2,732,150. Controlled Parallel and Helical Spooling, Nos. 2,708,080; 2,620,996. Appli. al grooving, Nos. 2,599,926; 2,204,938. Removable End Fillers, No. 2,216,819. Other patents pending.

CALIFORNIA

★ The first tidelands well at Redondo Beach, Signal-Artnell-Reserve City of Redondo Beach No. 1, was spudded on March 7 at the foot of Beryl Street at the ocean's edge. The joint venture between Signal Oil & Gas, Reserve Oil & Gas and Artnell Oil & Gas got under way after the voters of Redondo Beach approved drilling within the city limits at a special election held last November. Santa Fe Drilling Company is the contractor, employing a soundproof rig for the drilling job. The operators expect to find a prime producing zone at from 3500-4000 ft by slant drilling under the ocean from the on-shore location.

★ Honolulu Oil Corporation has spudded a deep test ½-mile east of production in the Buena Vista Hills field, approximately 6 miles east of Taft in Kern County. While the operators hope to find production above 10,000 ft, the rig is capable of carrying it to 12,000 ft if desired.

★ Richfield Oil Corporation made a new pool discovery in the South Cuyama field with completion on the pump of Hibberd No. 57-36 for 81 bbl per day of 28.2 deg oil. Richfield drilled the well as an injection well but salvaged it for a discovery when unexpected faulting made it impossible to use for injection. Total depth is 4359 ft, however the well was completed in the Bittercreek sand at approximately 2728 ft. The Bittercreek occurs just below the Santa Margarita sand, which gave Cuyama its first commercial well eight years ago at Russell Ranch.

★ Continental Oil and Merchants Petroleum companies have abandoned their joint venture wildcat near the intersection of Hellman Avenue and Atlantic Boulevard in the Monterey Park-Alhambra area of Los Angeles County. The operators had hoped to find production in Upper Miocene beds at around 5000 ft, but abandoned their project when basement rock was encountered at about 4425 ft.

★ Shell Oil and Tide Water Associated have staked location for an extension test of Shell's Vedder sand discovery of last June in the Strand field in Kern County. The joint venture will be Shell's first attempt to further evaluate the discovery. The new drill site lies two locations east of the 1100 bbl per day discovery well on the Posuncula lease.

★ Richfield Oil Corporation has made a new discovery two miles southeast of the main Wheeler Ridge field with the completion of KCL F No. 52-36. Initial production was 150 bbl per day of 41.5 deg oil and 883,000 cu ft of gas through a 48/64-in. choke, with 440 psi pressure over the packer and a gas-oil ratio of 6000 to 1. The 9213 ft well was completed from a plugged depth of 8950 ft from Lower Miocene sand. The Eocene sand, so prolific in the main Wheeler Ridge field, is yet to be tested in the new structure.

★ Oceanic Oil Company has made a deeper pool discovery two miles west of Taft in the Midway-Sunset field of Kern County with the recompletion of General American No. 67x-16 for 236 bbl per day of 23.2 deg oil. Production in the 4670-ft hole is from sand in the lower portion of the Republic section. Well was originally upper Republic.

★ Signal Oil & Gas Company has spudded another wildcat near the Mount Poso field to look for production in the Vedder sand. Site of the new test, Signal-Glide No. 31-1, falls about 2½ miles west of production on the Vanguard lease at the south end of the field, which is in Kern County.

★ Signal Oil & Gas Company is drilling a wildcat at Deepwell Ranch, 20 miles northwest of Bakersfield and 6 miles northwest of the Mount Poso field. This new test, Signal-Thayer No. 31-16, is programmed to drill to about 4000 ft to evaluate the Fasoso sand of Eocene age.

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What's doing in DRILLING

★ **U. S. and Canadian drillers** set new records in most parts of the country in March and April, falling behind in California and Canada. Although Canadian drillers were still 'snowed in," Californians just don't have the locations.

★ **Texas well completions** are about 10 per cent over last year, Railroad Commission reports show. Up until mid-April, completions totaled 4783, compared to 4270 finaled by the same period in 1955. Texas drillers have successfully completed 183 wildcats, as compared to 153 completions in previously-unproven territory last year. Dry holes in Texas, however, are about 14 per cent over last year's totals, 2254 to 1934.

★ **Louisiana permits** for drilling are running ahead of last year's tallies. At the end of February (last official data, reports show 352 requests to drill in the first two months of this year, as compared with 308 a year ago. In this period, three new fields have been discovered in South Louisiana: Grosse Savanne, Cameron Parish, oil at 9665-67 ft; East Cameron Block 62, gas at 7638-48 ft, and Theall, Vermilion Parish, gas at 11,580-93 ft. Also five fields have been extended. These are the Hayes, South Thornwell, Coward's Gully, Cow Pen Creek and Lake Washington.

★ **Drilling in Oklahoma** is hitting a fast pace with some 500 field wells and 75 wildcats underway. Exploration activity during April has been centered in the central part of the state.

★ **Alabama's Citronelle-Rodessa** field in Mobile County continues to draw new contractors and operators into the area. Zach Brooks, who made the field discovery, has just completed the eleventh producer, the No. 2 Fletcher. The well flowed oil on a drillstem test, after drilling to a total depth of 11,025 ft, setting pipe and perforating in the lower sand zone. Brook's No. 1 Coley was last reported drilling below 11,000 ft in the pay zone. Central American Oil and Allen Guiberson's No. 1 Walker was also coring below 11,500 ft. George D. Hunt has just completed a squeeze job on its No. 1 Collins. New work in the area includes Central Oil and Trans-Tex Drilling No. 1 Joy Unit; Trans-Tex No. 1 Carroll, Gulf Refining No. 1 Citronelle Unit 7.

★ **California oil men** are talking up a new 15,000-acre lease option in Kern County concluded between Shell Oil and the Kern County Land Company. Under terms of the transaction, one of the largest in Kern County history, Shell is given exploration rights on any part of the 24-mile block and may purchase any or all of the land involved if desired. Contractors foresee a major exploration play as a result of the deal, with the Eocene age as the drilling target.

★ **West Coast drilling** is currently centered around Central Petroleum's new deep zone discovery at Santa Fe Springs, California. At last report 11 rigs were operating in the vicinity. The discovery well is currently flowing 460 bbl daily of 33.9 deg oil cutting 2.8 per cent water through a 16/64-in. choke; the well is also making 496,000 cu ft of gas. Pressures are being maintained very satisfactorily with 1065 psi on tubing and 2080 psi on casing.

★ **Although California drilling** has been stimulated in certain areas and the Santa Fe Springs discovery promises new work, California's oil and gas division statistics show that completions and drilling notices are lagging far behind last year's number. By April 14 only 657 notices to drill new wells had been filed with the state oil and gas supervisor, as compared with 817 posted by mid-April, 1955.

★ **Road bans and spring breakup** have virtually shut down all drilling activity in Western Canada. For the week ending April 19, only 13 wells were completed in Saskatchewan, Manitoba, Alberta and British Columbia. Eight of the completions were in Alberta; four were finaled as successful field wells, one outpost became a gasser and three wildcats were abandoned. For the second time since 1954, Pembina field showed no well completion for a one week period. Saskatchewan accounted for one oil well, one gasser and two wildcat abandonments. Manitoba had one dry hole. British Columbia registered no completions.

★ **Impact of the weather** on oil field operations was much discussed at the spring meeting of the Rocky Mountain district, American Petroleum Institute division of production. Cost of drilling in the Rockies, say P. D. Romano and D. A. Rakestraw of Kerr-McGee Oil Industries, is increased from $1.35 to $4.05 per foot by the winter. Speakers at the meeting pointed out that automation and weather forecasting services were minimizing production problems, but little was said to comfort the driller on the derrick floor or the contractor wanting to move to the next location.

★ **Cost per barrel** of oil found in the Rocky Mountain region is still lower than in other major oil producing areas of the country, according to a recent Petroleum Information survey. Drilling cost per barrel found in Wyoming is 30 cents, in North Dakota 25 cents and in Colorado 65 cents; the U. S. average is 66 cents per barrel. In spite of the weather, drilling in the Rockies is up 23 per cent this year over 1955, a record year in itself.

★ **Finding oil in unproved areas** seems to be reaching a high in Gulf offshore waters. Forty-one per cent of the wildcat tests made in the Texas and Louisiana tidelands prior to January 1, 1956, found oil or gas; the national average is only 11 per cent. Senior vice presi-

Rotary Rigs Operating in Oil Fields of United States and Canada*

	March 19	March 26	April 2	April 9	April 16
Pacific Coast	125	124	128	131	133
Oklahoma	318	313	336	323	333
Kansas	180	180	176	176	175
Rocky Mountains	199	192	200	197	207
Canada	243	190	148	125	108
Ark-La-Tex	157	160	158	160	177
West Texas & New Mexico	564	538	569	562	569
Gulf Coast	661	666	650	651	633
Illinois	99	85	114	107	97
North Texas	383	385	381	375	361
	2929	2833	2860	2807	2793

*As reported to the American Association of Oilwell Drilling Contractors by Hughes Tool Company.

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* C-320D-120-25	
C-320D-84-30	
C-320D-84-27	
C-320D-74-27	C-114DA-54-16A
C-320D-74-25	C-114DA-54-15
C-228D-74-27	C-114DA-54-14
C-228D-74-23	C-114DA-54-13.5
C-228D-74-20	C-114DA-48-14
C-228D-64-23	C-114DA-42-10.5
C-228D-64-20	C-80DB-48-14
C-160D-74-20	C-80DB-42-10.5
C-160D-64-23	C-57D-48-10
C-160D-64-15	C-57D-42-10.5
C-160D-54-18	C-40D-40-7.4
C-160D-54-17	C-40D-34-8
C-114DA-64-15	C-25D-28-6
C-114DA-54-17	C-25D-24-6

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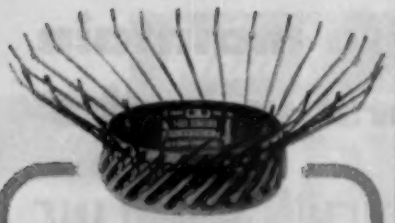
dent of Continental Oil Company, Ira Cram, has stated that a total of 155 wildcats drilled off the coasts of these two states has proved the existence of 64 oil and gas fields and perhaps found 1.5 billion barrels of oil and 10 trillion cubic feet of natural gas.

★ **Second deepest oil or gas test** in the world has been scheduled in south Louisiana by Tide Water Associated Oil Company. The new wildcat is to be located in Plaquemines Parish, not many miles from the depth-record holder Richardson & Bass well. Tide Water's test, expected to go to 21,500 ft, has been staked in the Buras levee district on the north flank of the Venice dome. If the operation reaches its projected depth, it will be 18 ft deeper than Ohio Oil's 21,482-ft hole in Kern County, California, but considerably shallower than the Richardson & Bass well, which went to 22,750 ft.

★ **Deep zone drilling** is spreading across the northern tier of Texas counties to tie into the fast development in the Oklahoma Panhandle. Lipscomb County is the newest added to the list on the Texas side, with shut-in completion of Humble's No. 1 Merydith as a gasser making 1,100,000 cu ft of gas and 29 bbl of condensate per day on a ¼-in. choke on initial potential test. This well is 15 miles from the Barlow-Morrow field and 14 miles west of Lipscomb taking production from the Keyes sand at a depth of 10,163-205 ft. About a dozen rigs and now running in Ochiltree County, Texas, at the east end of the area. Production now spreads from the east side of the tri-state Hugoton gas field in Hansford County, where Humble, Baker & Taylor and the Sharples Company were very active in 1954. There are now 12 fields in the east two-thirds of that county, most of them awaiting pipe line outlets.

★ **Texas RRC district three** activity is focused in the Pierce Junction field, creeping nearer the south city limits of Houston. About 16 rigs are running in that area, ranging from slim hole units to some of the largest, and are drilling land broken up into city-sized lots, the city-owned dump, and even on a car-storage depot. One test is being drilled on a 25-ft wide by ¼-mile long plot by R. H. Hedge and H. C. Cockburn. A sizeable gas well has been brought in 2500 ft from the Holmes Road Dump by the Texas Company. This well is the fifth on a Katie Jewell tract, and was potentialed at 2,303,000 cu ft of gas daily through an 8/64-in. choke. The four Texas wells are oilers. Another Pierce Junction well just completed is the Group Oil Company No. 5 E. R. Odom, flowing 142 bbl of 24.5 deg oil through a 12/64-in. choke from 6864-82 ft.



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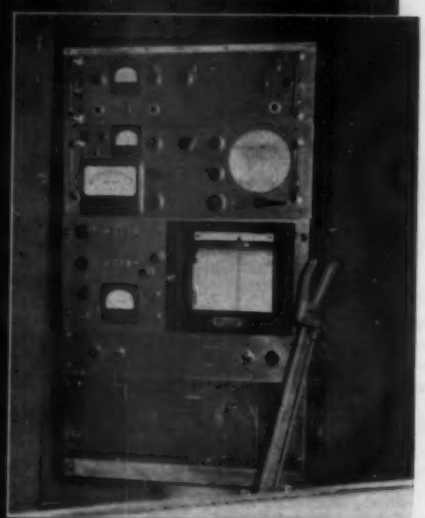

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RUNNING TOUR with MEN in the INDUSTRY

H. R. Moorman, former manager and executive vice president of Mobil Oil of Canada, Ltd., has become a member of the Socony Mobil Oil Company, Incorporated, worldwide producing committee with headquarters in New York. His successor as manager and executive vice president of the Canadian affiliate, with headquarters in Calgary, is **Fred H. Moore,** former assistant to the president of Magnolia Petroleum Company, Socony Mobil's Southwest affiliate.

H. R. Moorman

Moorman joined the company in 1939 as assistant chief geophysicist, and had held his most recent position in Calgary since 1952.

Leonard R. Seaman has been elected president of Intex Oil Company. He began his oil career in 1936, joined Intex in 1945, and is a director of the IPAA.

S. W. Totten has been appointed vice president and general manager of exploration for the western region of The California Company, Denver, Colorado.

Brame Womack, division geologist, Sohio Petroleum Company in Oklahoma City, Oklahoma, has been promoted to exploration manager. Other company appointments are: **P. C. Rennie,** district engineer at Tyler, Texas, has been transferred to Pauls Valley; **J. Craig Coogen,** senior engineer in Oklahoma City, replaces Rennie at Tyler.

J. T. Holten Jr., petroleum engineer, has been employed by Cosden Petroleum Corporation and assigned to the western producing division of the company. He was previously employed by Gulf Oil Corporation.

Establishment by Continental Oil Company of a new Gulf of Mexico exploration division, with headquarters in Houston, Texas, has been announced. The new division will be responsible for Conoco exploratory operations in the Gulf of Mexico, except those conducted by the company for the CATC Offshore Group.

Key men in the division, all of whom will be headquartered in Houston, are: **C. E. Greenwood, Houston,** assistant to the southern regional geologist, promoted to division geologist, Gulf of Mexico division; **L. Ray Tucker,** Houston, landman, promoted to Gulf of Mexico division land superintendent; **C. H. Gullick,** Fort Worth, Texas, southwestern region geophysical supervisor, promoted to Gulf of Mexico division geophysicist; **Sam M. Udden,** Houston, geologist, promoted to assistant division geologist for the Gulf of Mexico division.

S. R. Cross has been promoted to assistant regional geologist for Continental Oil Company's central region, with headquarters in Oklahoma City. Formerly division geologist at Wichita, he succeeds **P. R. Warren,** who recently was promoted to regional geologist. Cross joined Conoco in 1946 and served as division geologist at Wichita since 1952.

James V. Neuman Jr., vice president of United States Smelting, Mining and Refining Company, has been named general manager of oil operations. Previously Neuman had been manager of the southern division of the oil department. He succeeds **C. G. Rice** who is executive vice president.

The company has consolidated oil headquarters with the Midland base, abolishing the southern and northern divisions. **George S. Anderson** has been promoted from assistant to Neuman to division manager in Denver, Colorado. **Holly G. Peacock,** previously assistant to the president of U. S. Smelting, has been named manager of the Midland, division office.

Vernon Blain has been elected president of the John Drilling Company, Fort Worth, Texas, replacing **Johney Cockburn** who has resigned. Previously executive vice president and drilling superintendent, Blain is succeeded by **John St. John,** vice president.

James A. Smith Jr. has been elected vice president in charge of production, by Woodley Canadian Oil Company, subsidiary of Woodley Petroleum Company. Formerly with Ashland Oil & Refining Company, Smith will be in charge of Woodley Canadian's newly opened production office at Regina, Saskatchewan, Canada, and of the company's producing operations throughout Canada.

Humble Oil & Refining Company announced the following changes in its production department supervisory personnel. **H. W. Brown,** petroleum engineer, transferred from Anahuac district to Katy gas cycling plant, Gulf Coast division. **J. A. Reed, II,** petroleum engineer, moved from Katy gas cycling plant to the gas engineering division, Houston, Texas. **J. R. Boswell,** civil engineer, transferred from Conroe district to the Gulf Coast division office in Houston. **C. W. Armstrong Jr.,** assistant division petroleum engineer, North Texas division, was transferred to the Winters district as assistant district superintendent.

P. W. McFadden, district superintendent, Winters district, North Texas division, transferred to the Gulf Coast division, as district superintendent for the new district set up. **C. S. Yust,** assistant district superintendent, Winters district, was promoted to district superintendent replacing McFadden. **J. P. Sutton,** junior petroleum engineer, transferred from London district. East Texas division, to Hobbs district, western division.

Thomas S. Harrison has retired from the Argo Oil Company, Denver, Colorado, after 30 years as geologist.

Rex Shaver, previous vice president, has been elected president of H. L. Rowley, Incorporated. **Stephen Rowley,** son of the founder and past assistant to the president, has been named vice president. **Carl G. Kendrick,** assistant secretary-treasurer, has been promoted to secretary-treasurer, and **W. H. Son,** with the company since 1948, is the new drilling superintendent. **H. L. Rowley, G. D. Murray** and **Charles F. Hayes,** president, vice president and secretary-treasurer, respectively, have resigned.

R. J. Adams, former Southwest regional geologist for Phillips Petroleum Company at Bartlesville, Oklahoma, has been promoted to division manager at Corpus Christi, Texas. **J. H. McLaren,** division landman has been named assistant division manager. **Donald A. Butler** has resigned as geologist for Aero Service Company and joined Phillips at Bartlesville.

Texas Pacific Coal and Oil Company's exploration department has announced these promotions: **Edd Riddle Jr.** named to Midland, Texas, division exploration manager, transferring from the Canadian division where he has been serving as exploration manager. **T. Wayne Hurt,** former assistant in the Canadian division, succeeds Riddle as manager. **Nolan Hirsch** is advanced from district geologist in Midland to chief exploration and development geologist in the Fort Worth, Texas, home office, replacing **W. L. Gupton Jr.,** resigned. **Robert L. Porter,** former Abilene, Texas, sub-surface geologist, joins the Fort Worth exploration staff as assistant to Hirsch. **Cecil Aycock,** former assistant to Hirsch, becomes district geologist in Midland district.

William B. Macey has joined Western Development Company, Santa Fe, New Mexico, as vice president. Formerly he was director of the New Mexico Oil Conservation Commission and geologist for that state.

Frederick L. Stead has resigned as western division exploration manager of Ada Oil Company, to accept the position of chief geologist with the McAlester Fuel Company. Stead opened Ada's Midland, Texas, offices over two years ago, before which he was a district geologist with Continental Oil Company in Midland. Previously he was an industructor of geology at the University of Texas, Austin, Texas.

F. L. Stead

Lewis M. Thompson, drilling and production engineer with Cosden Petroleum Corporation, has been promoted to manager of the Big Spring, Texas, headquarters.

George V. Myers has been appointed general manager of production for Standard Oil Company (Indiana). Myers, who joined Stanolind in 1953, has been financial vice president and a director of Stanolind Oil and Gas Company at Tulsa, Oklahoma. He will coordinate production and crude oil supply activities of Standard Oil with operations of such principal subsidiaries as Stanolind Oil and Gas Company, Service Pipe Line Company, Stanolind Oil Purchasing Company, and Tuloma Gas Products Company.

Harvey L. Hurley, former vice president of Great Basins Petroleum Company of Denver, Colorado, recently resigned to become an independent oil operator and producer with offices in Denver.

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McCullough Log Finds an Oil Well Where Dry Hole Was Expected

An electric log, run in this semi-wild cat well in Oklahoma, showed a little less than nine feet of possible pay with a small shale break in the center. This was followed by a micro-log which showed very poor permeability in both sections of the sand. From these findings the operator expected a dry hole.

However, a McCullough Radiation Well Log was run, obtaining Gamma Ray and Neutron Curves and recording a simultaneous collar log. The Gamma Ray-Neutron curves accurately located and defined 12 feet of pay sand with two feet of shale in the middle and showed both sections of the sand to be porous.

The well was perforated from logging measurements in a single run by McCullough Super Casing Glass Jets in a Steel Strip Carrier with the two foot shale section blanked off. Thirty-six holes, four per foot, were fired in the two sands.

After perforating, the Steel Strip Carrier was pulled and a bailer was run in the hole. Returns were mud cut oil. Bailer was again run after a 20 minute wait and fluid level had risen 225 feet.

Because of the accurate, reliable information provided by McCullough's Radiation Well Logger, this well proved a valuable extension to an established field.

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Accurate, reliable down-hole information provided by McCullough Gamma Ray–Neutron curves located and defined the gas sand responsible for this wild blow-out. The presence of this sand had not been indicated by a previous electric log nor by the drilling log.

The well blew wild on January 16th, burning approximately 15,000,000 cubic feet of gas daily. Numerous attempts, by experts, to kill the well were unsuccessful.

A directional relief well was drilled to 2800′ and cased with 7″ O.D. 23 lb. cemented pipe. Water flood operations were started and about 250,000 barrels of water were injected into the formation suspected of being the cause of the blow-out and fire. Flooding efforts at this depth proved futile. There was no reduction in the volume of gas flow.

McCullough ran a radioactivity log in the relief well and the Gamma Ray and Neutron curves definitely established a substantial gas sand at approximately 2600′, considerably higher than the previously suspected formation. This sand had been completely missed by both electric and drilling logs.

A Bridge Plug was set below the newly discovered sand, cement was dumped on the plug and the zone was perforated by McCullough M-3 Bullet Guns.

Water injection procedure was again started. Five days after the discovery of the new zone, gas flow was reduced to a point where the flame was extinguished and the well brought under control. Another tribute to the efficiency of McCullough's Radiation Well Logger.

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Personals

L. P. Foote, the former assistant chief petroleum engineer of The Ohio Oil Company, has been appointed manager of the newly created natural gas division. **Fred C. Aldrich,** formerly of the petroleum engineering department, will supervise contracts, rates and gas sales engineering in the new division.

Foote joined Ohio Oil in 1935 and has worked in the refining and production department. Aldrich has worked with Ohio Oil since 1948.

Chas. T. McCord Jr., Shreveport, Louisiana, oilman has announced the formation of McCord Oil Company. The new firm in Shreveport will specialize in developing oil and gas properties in the Ark-La-Tex area. McCord has been active in the oil business for the past twenty years.

Theodore A. Link, president, Link, Downing & Cooke, Limited, became the 40th president of the AAPG in April. Also on the 1956-57 executive committee of this geological organization will be **G. M. Knebel,** manager, exploration division, Standard Oil Company (N. J.), New York City, past president; **Ben H. Parker,** president and director, Frontier Refining Company, Denver, Colorado, vice president; **W. A. Waldschmidt,** consulting geologist, Midland, Texas, secretary-treasurer; and, editor of the AAPG monthly bulletin will be **W. C. Krumbein,** professor of geology, Northwestern University, Evanston, Illinois.

William E. Wrather, former director of the United States Geological survey, has been chosen to receive the Sidney Powers Memorial Medal by the AAPG. One of the AAPG founders and president in 1922, Wrather was made an honorary member for life in 1943.

Frank Neighbor, with Sun Oil Company, has been elected new section president of the Rocky Mountain Section of the AAPG at its sixth annual convention. He succeeds **F. A. (Gus) Thurman. Dave Moore** is the new vice president and **Walter Quigley** new secretary-treasurer. Quigley's twin brother, **Darwin Quigley,** representing Utah, is one of five new state representatives. Other state representatives added to the board are **Richard Oburn,** Denver, for Colorado; **Paul Richards,** Billings, for Montana; **Otto E. Brown,** Durango, for New Mexico; and **John Miller,** Casper, for Wyoming.

James Law, geologist, The California Standard Company, Calgary, Alberta, Canada, and **Lt. Robert H. Dott Jr.,** Air Force Cambridge Research Center, Bedford, Massachusetts, each were chosen to receive the President's Award at the AAPG's annual April convention in Chicago.

Judged as articles with the most significant contribution to petroleum geology, Law's article is entitled "Geology of Northwestern Alberta and Adjacent Areas," and Dott's "Pennsylvania's Stratigraphy of Elko and Northern Diamond Ranges, Northeastern Nevada."

Stuart E. Buckley, Humble Oil & Refining Company, received the Anthony F. Lucas Gold Medal at the annual AIME meeting. Won by outstanding service, it is the highest honor given by this society.

Thomas C. Frick, Atlantic Refining Company, is the new petroleum branch chairman of AIME. He succeeded **Robert B. Gilmore** of DeGolyer & MacNaughton.

Bob Walker, Gulf Oil Corporation, has been elected chairman of the Illinois Basin chapter of AIME. **George Link,** Carter Oil Company, is first vice chairman; **Jim Dorland,** Calvert Drilling Company, second vice chairman; and **Fletcher Farrar,** independent operator, secretary-treasurer.

Dr. Raymond Cecil Moore, University of Kansas, was elected an honorary member of the SEPM at the society's 30th annual meeting in Chicago, Illinois. He is one of three living SEPM members to be so honored.

Dr. Moore was State Geologist of Kansas from 1916 until 1954 and taught geology at Denison University and the University of Kansas, where he has been professor since 1919. He also was chairman of the geology department at Kansas University from 1920 to 1939 and again from 1952 to 1954. Moore has been editor of the AAPG *Bulletin* and the SEPM's *Journal of Paleontology* and *Journal of Sedimentary Petrology* and was president of SEPM in 1928.

Frank A. Morgan, former vice president and manager of exploration for Richfield Oil Corporation, has opened engineering offices in Los Angeles, California, where he will be associated with his son, **Frank A. Morgan Jr.**

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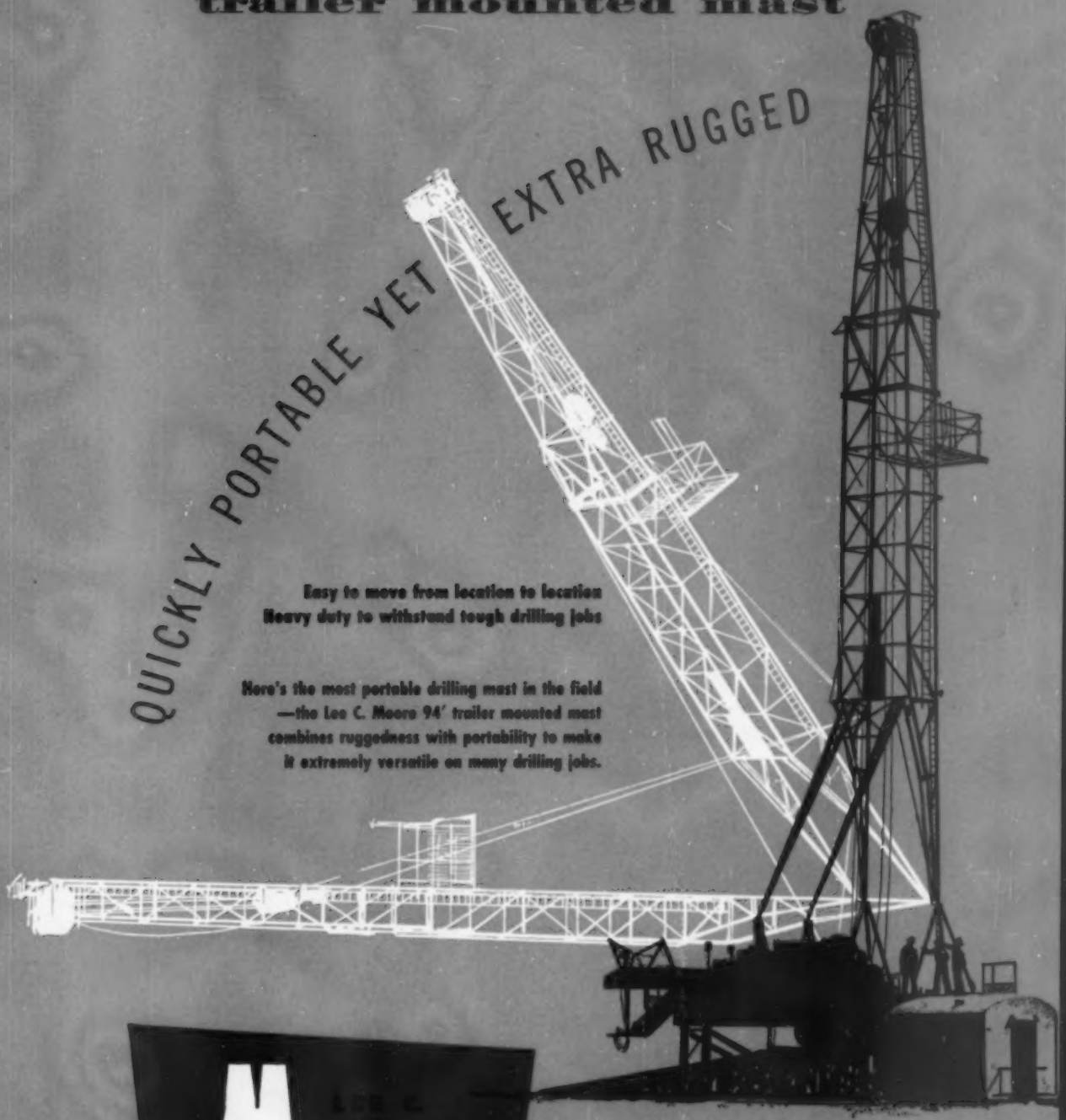

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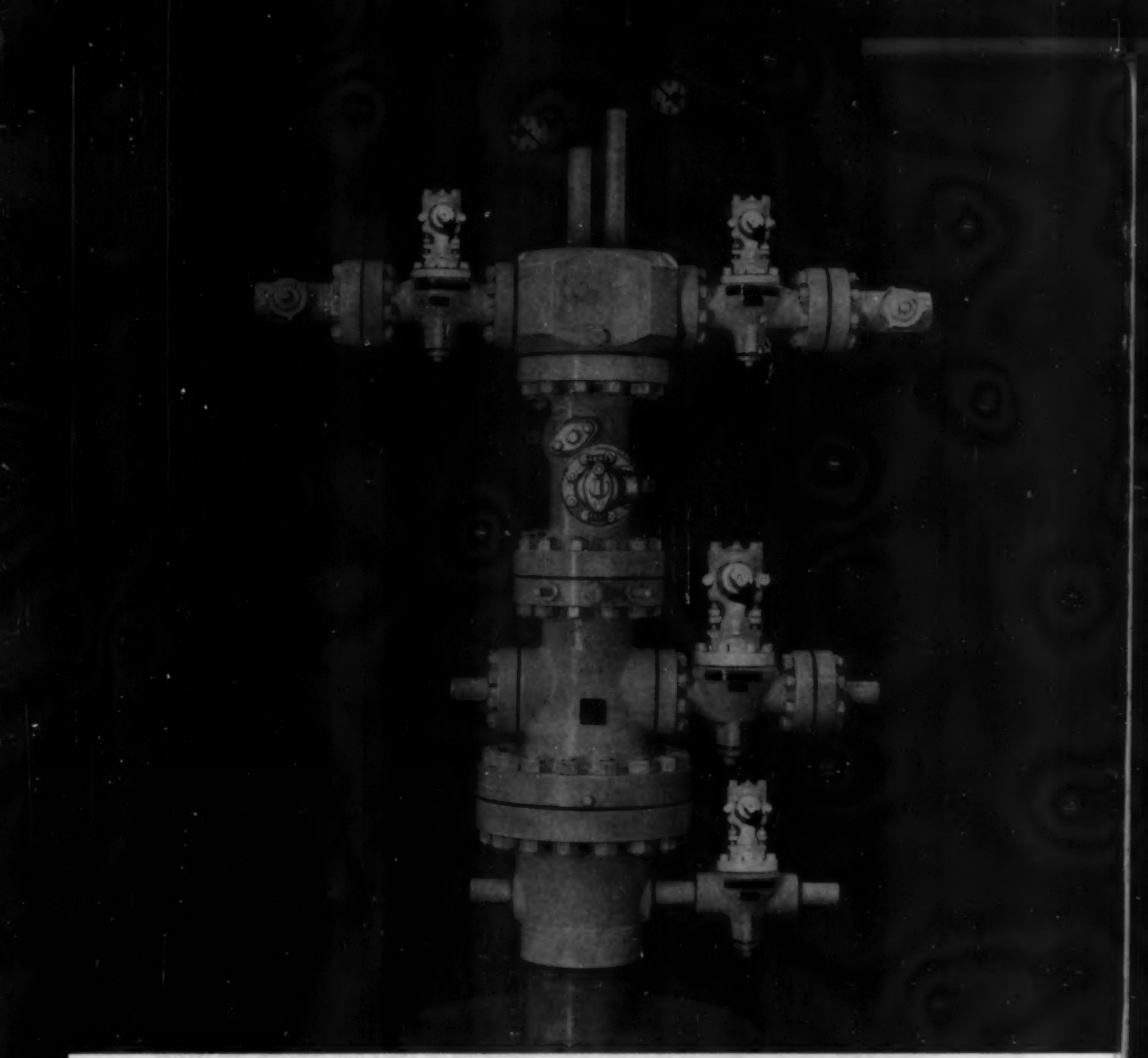

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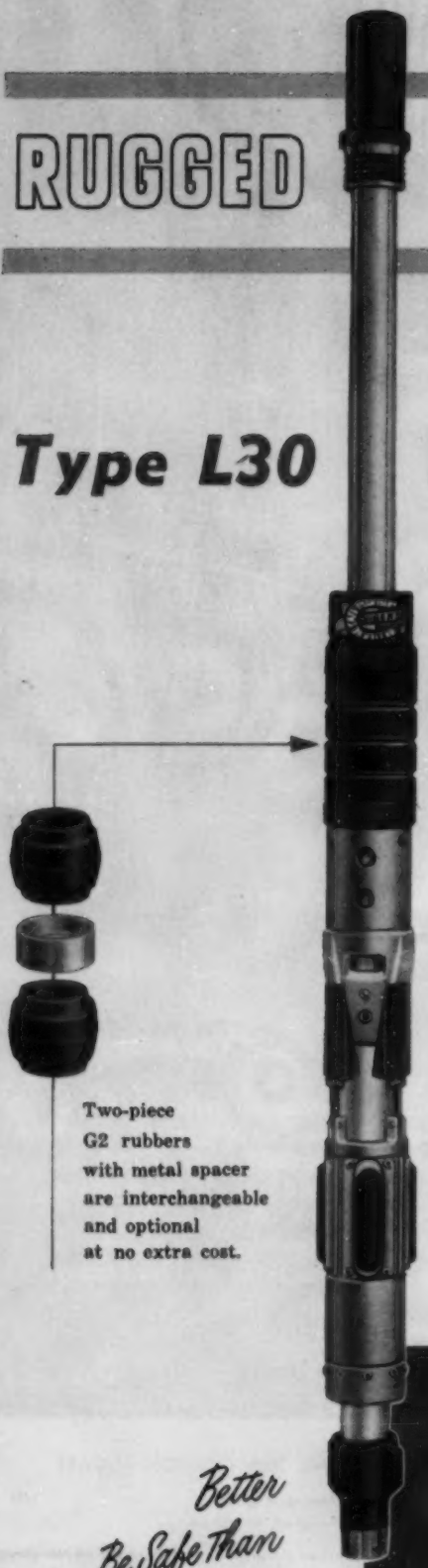

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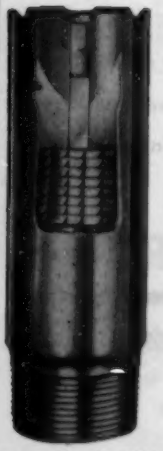

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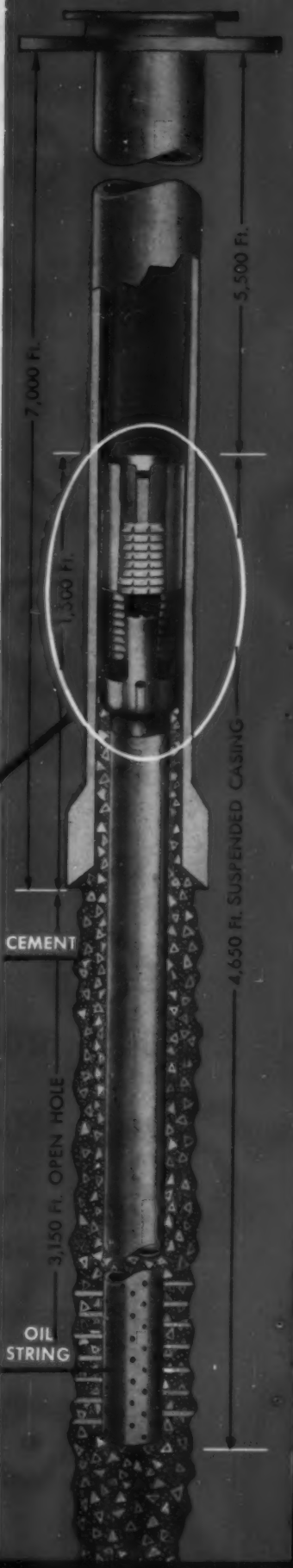

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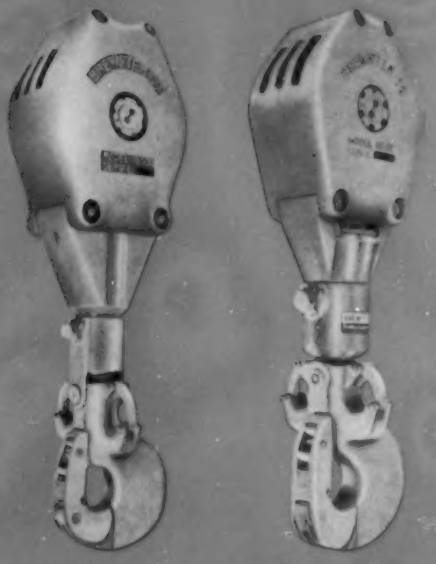

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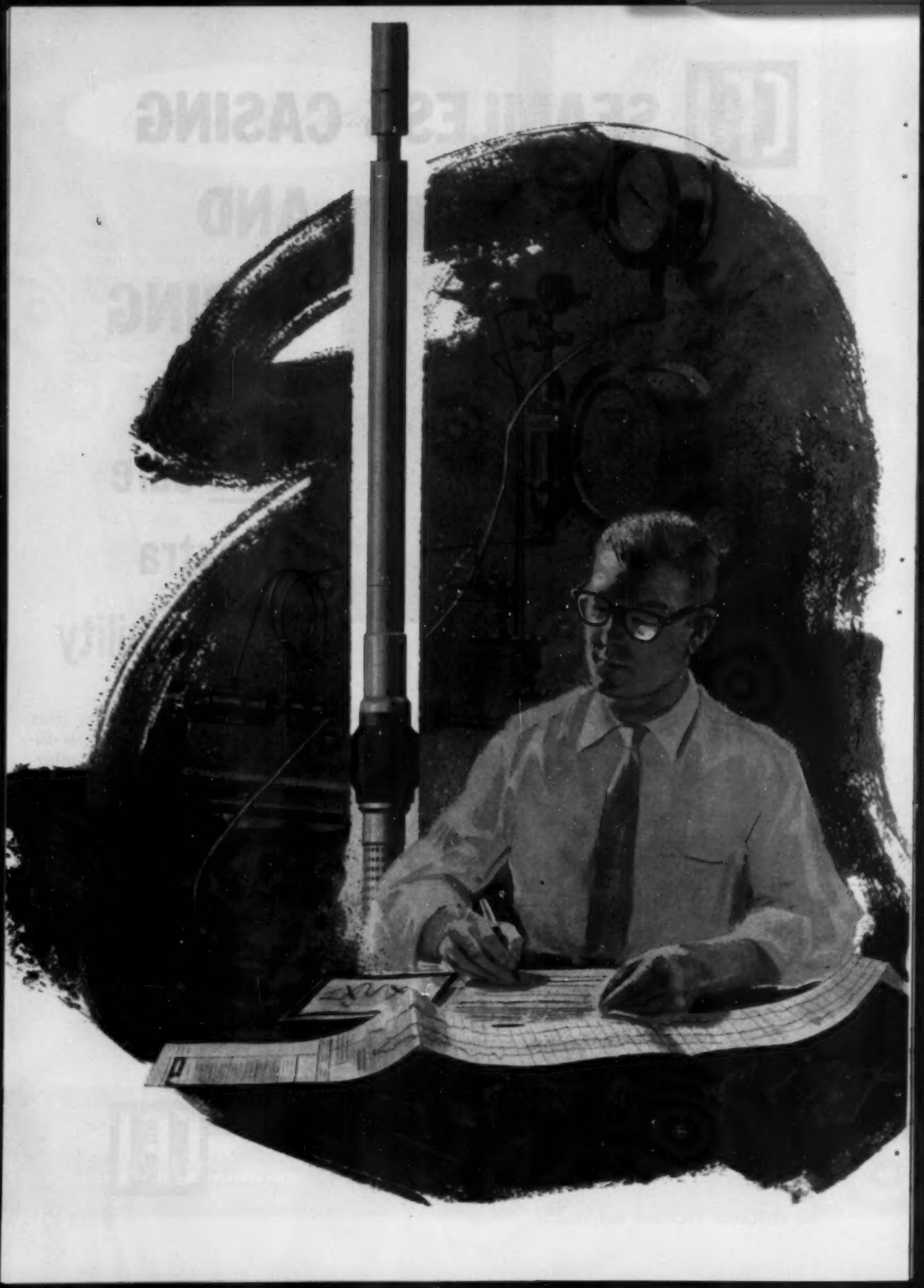

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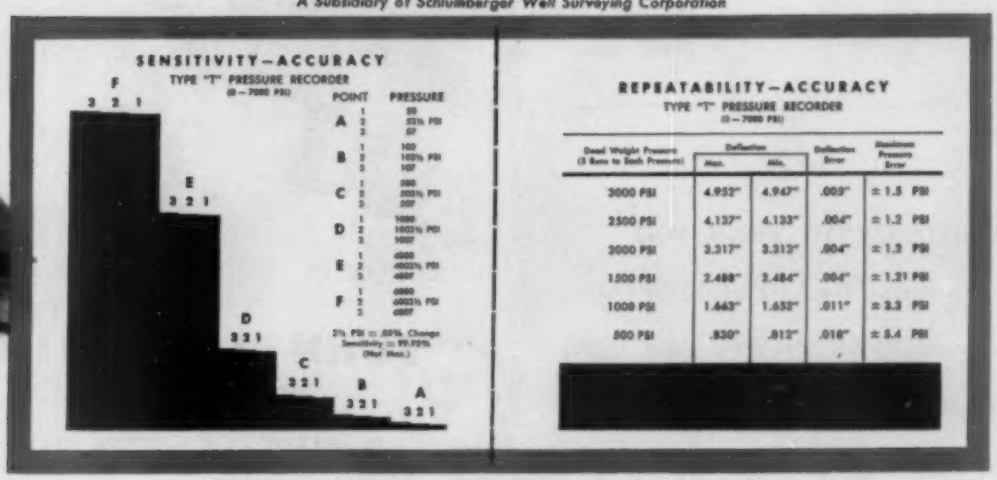

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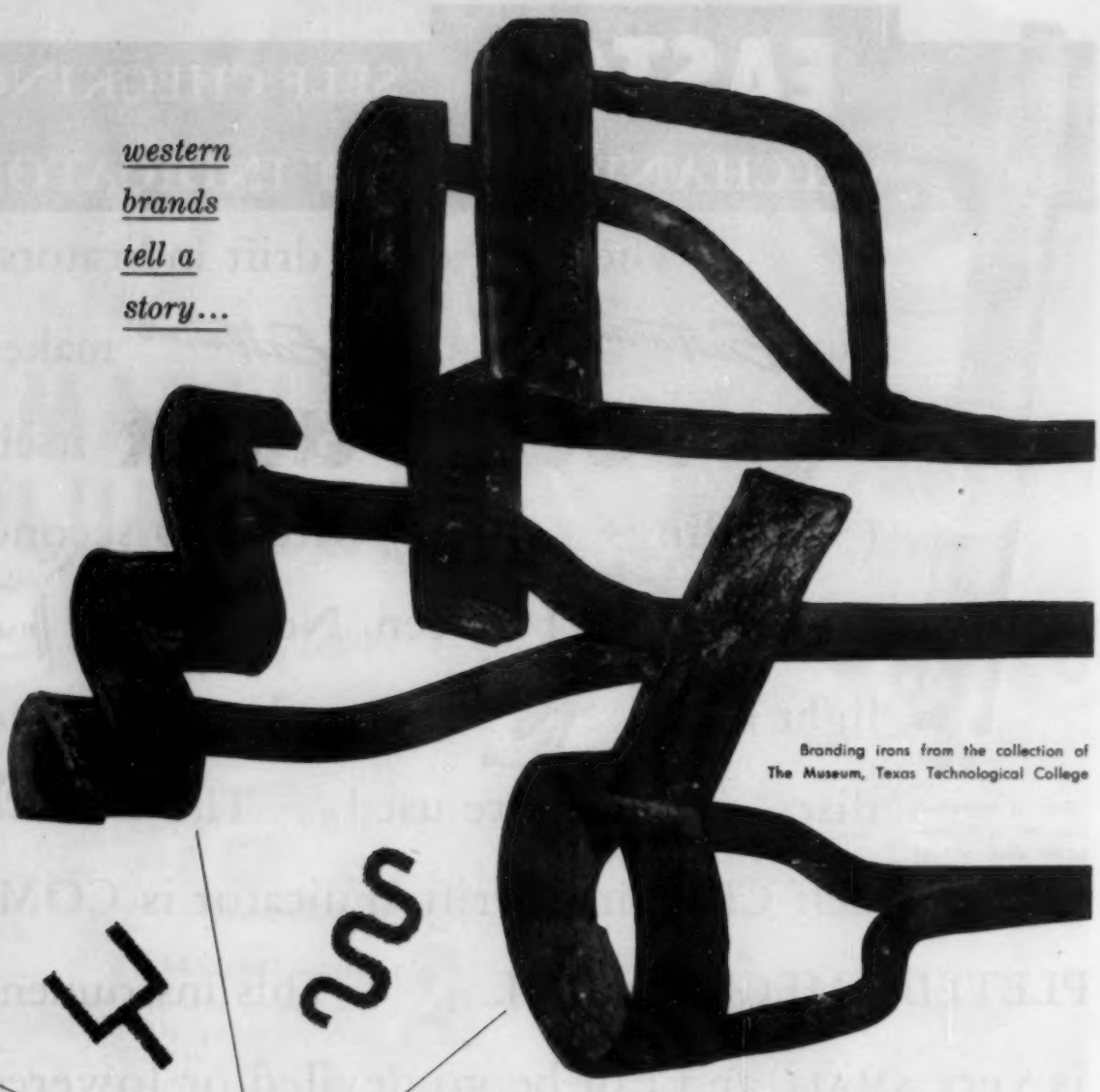

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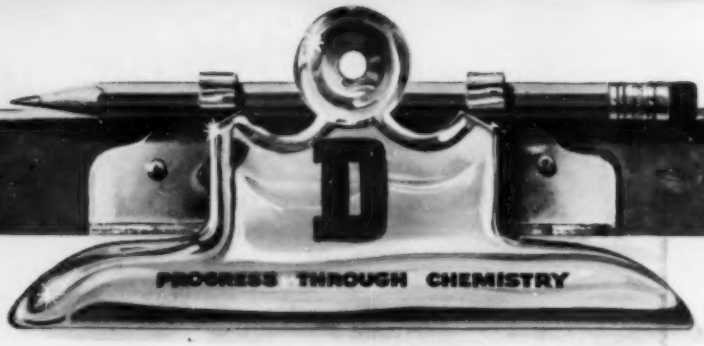

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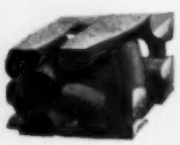
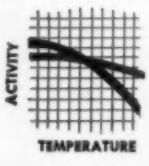


Structural Stability, Catalyst in the form of submicroscopic filaments provides the surface area on which catalytic reactions take place. Large filaments give greater mechanical strength.

Thermal Stability, The graph compares high pore diameter catalysts (in blue) with ordinary catalysts. By resisting heat deactivation, high pore diameter catalysts have a higher useful activity.



Chemists Charting Petroleum's Course

The 129th national meeting of the American Chemical Society, just concluded in Dallas, Texas, has come to be much more than just another huge conclave of a scientific organization. The tremendous mass of data presented before its numerous sessions and 21 divisions is not composed of mere dry-as-dust facts and figures. It becomes a progress report to the world that, in the long run, finances the research of industry, a report of the stewardship of the chemical profession, working for the chemical industry, of the "talent" given them in chemical literature, chemical training.

Literally, modern chemistry enters by the front door into every possible phase of human life and activities; it aids the human race before birth, during life, and after demise. Biological and medicinal chemistry produce antibiotics, disinfectants, anticeptics, to extend the life of people. Few classes of organic compounds cannot be synthesized by starting with a petroleum or natural gas hydrocarbon. Foods, clothing, rocket propellants, plane engine fuels, paints, rubber — all may start from simple carbon-hydrogen compounds, available in relatively untold quantities.

Consequently, the parade of new materials, better products is uninterrupted. The discovery of "Alladin's Lamp," known to modern scientists as the catalyst, is doubtless the greatest single development in modern chemistry. The action of catalysts was known in a small way long before the work of Sabatier, Senderens, McAfee, and a host of earlier experimenters; yet it remained to the last two decades to show how catalysts can take the center of the chemical stage and hold it against all comers.

In petroleum we have two developments, especially, each trending to render the other obsolete, and in each the catalyst plays a major role. Millions of dollars are being spent on the improvement of processes to enhance the octane rating of spark-ignition fuels. Tetraethyl lead, (TEL), is the only really successful catalyst for improving motor gasoline burning qualities under pressure; other "catalysts" are boron, iron carbonyl, and some others, but none have achieved any great commercial success.

Now comes the gas turbine, the jet engine, which cares not a whit for Octane or any of her tribe, which calls

Carl Shipp Marvel

M. J. O'Neal, Jr.

for fuels, "with only the Suttee's passion, to do their duty and burn!" This fuel calls for properties of clean, rapid burning without deposits that damage equipment. Diesel engines call for fuels that burn quickly, uniformly and without power-robbing ignition delay. Chemicals such as amyl nitrate and several others show varying degrees of improvement in this line, permitting the refiner to supply more uniform, more efficient fuels. Deposits are the jet engine's worst enemy. That problem is being attacked in ways analogous to the attack on gasoline's problems, with a two-edged sword—refining processes for betterment, and addition agents, derived from petroleum or other sources, that improve individual properties. The fairy tale that jets can burn "anything" efficiently has gone the way of its Siamese twin, the story that diesel engines can burn *anything* efficiently. The diesel, the jet, and the gasoline engines are locked in "mortal" combat of competition. The most far-seeing industry leaders say each will stay with us and do the job it can do better than either of the others.

In the realm of the chemistry of petrochemicals, advances are coming so rapidly that no textbook can be anything but obsolescent; by the time facts can be assembled in a printed book, the forefront of progress has made those facts "ancient" history. Fifteen years ago civilization as we know it struggled with the crisis of a rubber "drought"; the outcome after millions of man-hours of thought, experiment, and sleeplessness is that never again can this country's freedom be placed in jeopardy by cutting off supplies of natural rubber. Chemists have made more different kinds of synthetic rubbers than Dame Nature ever thought of. In Dallas, 76,000 American chemists, 5,000 of them in person, granted the greatest of all American Chemical awards, the Priestley Medal, to Carl Shipp Marvel, Illinois University's versatile researcher, for outstanding services to the industry for his work in polymers-synthetic rubber, plastics, and synthetic fibers.

M. J. O'Neal, Jr., has done what many others considered to be impossible, remaking the mass spectrometer to make it possible to identify high-molecular weight materials in mixtures of various components, in Shell Oil's research laboratory. For this, he was given the Precision Scientific Company's award in petroleum chemistry. Identification of products is imperative, if the results of research are to be known and used.

Another of the fundamental tools used by the researcher is that of elevated pressure. One of the famous pioneers in applying ultra-high pressures to promote chemical reactions was the late great Russian, V. N. Ipatieff, who spent his last days as an American citizen using both pressure and catalysis to extend the limits of chemical knowledge. The triennial Ipatieff Prize with its $3000 honorarium was granted to Professor Harry G. Drickamer of Illinois University, for his signal contributions to the science of the application of pressure to research on molecular structure and molecular interaction.

The field of catalysis and of catalysts is emphasized also by the recent election of A. G. Oblad, Houdry Process Corporation, to the chairmanship of the Division of Petroleum Chemistry Society, a worker long active in both the society and in the application of catalysis to petroleum refining and petrochemicals manufacture.

Alex G. Oblad

. . . many refiners are still trying to catch up . . .

About your top octanes . . .

Refinery Consultant Melvin Gertz answers your questions about the industry's hottest subject

As a service to the refining industry, Ethyl Corporation asked Refinery Process Consultant Melvin Gertz* what can be done to control the increasing cost of top octanes! Here is the interview:

Q. *Are we approaching the end of our present cycle of refinery expansion and modernization?*

A. No. Many refiners are still trying to catch up with the demand for petroleum products. At the same time, two problems have necessitated more building: (1) a leveling out in the market for heavy fuel oil, and (2) octanes have steadily increased.

Q. *How is the industry solving these two problems?*

A. Refiners have accomplished the reduction in fuel-oil yield by installing new cat crackers, increasing coking installations and expanding asphalt production facilities. And fortunately, the addition of cat crackers has also considerably helped in meeting the demand for higher octanes.

However, octane increases have made refiners look to other processes and so that's why we have witnessed a wave of catalytic reforming installations over the past few years.

Q. *What would you say is the major problem that refiners are trying to meet?*

A. Certainly, today, the major emphasis is on filling the need for higher octane fuels.

Q. *Is expansion planning more difficult for the refiner today than, say, ten years ago?*

A. Yes, it is. Although we now have more processes to choose from and our technology for dealing with problems has improved, the industry has reached the octane level where each step requires careful analysis. Moving above the 98 octane level into the 100 plus octane range is expensive, no matter how you do it, and, in some instances, the end products are quite different.

Q. *In your opinion, what processes should a refiner consider in the 98 to 100 plus octane range?*

A. High-severity catalytic reforming, alkylation, isomerization—and combination processes such as catalytic reforming followed by extraction and thermal reforming. All of these processes have their own merits, and in a given refinery each would result in a different combination of gasoline yields and octane ratings.

Q. *Even with the differences in processes, isn't the problem still a matter of finding the cheapest way to produce 100 plus octane gasoline?*

A. No. It just isn't that simple. In some of the newer cars, the engines are relatively mild so that the road octane rating very closely follows the research octane rating. But for many of the new cars, there's some depreciation in road performance below the research rating.

Therefore, in planning octane improvement processes for the future, much consideration must be given to

. . . each step requires careful analysis.

*A partner of Purvin & Gertz, Dallas, Texas.

hydrocarbon composition and performance in vehicles as well as to the primary objective of ratings made in the laboratory.

Q. *Are there any other factors in process selection?*

A. Yes. The next factor to be considered is volatility. In some companies there is a definite trend to high volatility gasoline which necessitates removal of many higher-boiling-point top-octane components such as polymer gasoline and heavy cat naphtha from the premium blends. If this trend continues, it will have a significant effect on the selection of future processes. In other words, in addition to merely research octane ratings which have been the primary yardstick for the past few years, economic considerations at this time must be weighed

Moving above the 98 octane level into the 100 plus octane range is expensive . . .

in the light of either present or future importance of such factors as road rating and volatility.

Q. *Don't these various factors depend to a great extent on what automobile manufacturers will be doing for the next ten years in engine design?*

A. That's true and I feel a coordination of effort between the petroleum and automotive industries is of extreme importance at this time. Otherwise, refiners will be hard pressed to make a realistic decision if they are planning to modernize their plant facilities.

Q. *After a refiner has selected his process facilities and built his new plant, are most of his problems behind him?*

A. No, striking the optimum level of operation for all such facilities in a plant becomes a very complex prob-

The optimum combination of severity and lead concentration is . . .

lem. For example, when most catalytic reformers were initially installed, they operated at relatively mild severity, and further octane improvement could be achieved with relatively small incremental losses in yield. Under these conditions the cost of an incremental increase in octane expressed as cents per Research octane number barrel was frequently as cheap in the reformer as it would have been with the use of increased lead. However, with the increased severity demand from cat reformers today, it is generally advantageous to use rather high concentrations of lead.

The optimum combination of severity and lead concentration is something that would be peculiar to each refinery, depending on the particular processing facilities and the charge stocks available. Studies of this type should be made with regularity in order to take maximum advantage

Studies . . . should be made with regularity . . . to take maximum advantage . . .

of the facilities available in satisfying your market requirement at any given time.

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Mathematical Engineering as applied to Design and Operations

J. R. Cobb and R. L. McIntire

Phillips Petroleum Company, Process Development Division

I. Problems Requiring the Mathematical Engineering Approach

A. **Process Design.** Separation of hydrocarbons is of extreme importance to the entire gasoline industry. Sharp separations requiring a high purity of products are characteristic of the petrochemical productions. Design of absorbers, strippers, stills, and rich oil deethanizers has long been a time-consumer for the engineer in process design work. Intimately coupled with the problem of designing a fractionation column is the evaluation of thermodynamic data.

Here, we have used reduced correlations and lengthy empirical equations of state in efforts to interpolate and extrapolate experimental PVT data. These methods, when they are successful, are of tremendous importance since such correlations can be used with the thermodynamic equations of state to derive consistent enthalpy and equilibrium data. Calculations aimed at the design of thermal or catalytic crackers place great demands on the mathematical engineer. The design of the number of tubes in a thermal cracker, for example, requires a combination of kinetics, heat transfer, and pressure drop correlations.

Presented under the title, "Mathematical Engineering at Phillips Petroleum Company," before the NGAA, Ft. Worth, Texas, April 11-13, 1956.

B. **Equipment design.** One of the everyday problems of our engineering departments is the design and construction of pipe lines. Stresses and strains in critical bends must be computed. The pressure drop expected in long sections must be estimated and horsepower required for a gas accumulation system must be predicted. Condensers for fractionators are to be sized by computing with the heat transfer coefficients that exist in the two-phase systems. One of the ugliest problems in unsteady state raises its head when control instruments are to be located properly on a unit. Here, transient effects give rise to differential equations and their corresponding problems in boundary conditions.

C. **Production.** One of the most severe economic problems in the petroleum industry is the location and subsequent recovery of oil and gas from the ground. Many companies justify large computing installations for this one field alone. The geophysicists must use mathematical models to design equipment necessary for seismic surveys and to interpret the results of these surveys. The current price of drilling a well (whether it is dry or not) approaches or surpasses the purchase price of one of the medium-sized computers we will soon describe. Accurate estimates of the effects of fracturing a well, of steam injection, of water flooding, and of acidizing (to mention a few cases) promise to yield very quick payouts for the mathematical work involved. In the reservoir, the radial flow of fluids through the porous rock must be predicted. Once the oil is above the ground, further conservation must be practiced by determining the most favorable method of stabilizing the oil. Flash pressures and temperatures and flash tank orientations must be studied. In some instances, simple fractionations in the field are profitable, and these cases each need examination at the desk of the engineer.

D. **Operations Research.** Recent literature in the trade journals and in strictly mathematical publications alike have emphasized the attention that is being given to a technique called mathematical programming. Here, we study company operations through the eyes of mathematical models. Although the theory of these techniques can become involved, the actual numerical operations that are performed are extremely simple. For example, the optimum transportation of LPG from, say, 50 origins to 400 destinations is a linear problem that does not require a division for its solution. Several hundred thousand additions and subtractions are necessary. Blending of motor fuels and avgas for maximum profit and simultaneous acceptability is a second example of a typical operations re-

Saving Invaluable Time—

The unthinkably complicated calculation system required in designing an absorber or other plant unit offers well-nigh insuperable obstacles to economy of time and money, if carried out manually by engineers with their slide rules. By applying 10 "steps" to each "pass" (trial calculation "balloon") weeks of work can be reduced to hours, as shown by specific examples in this article.

search problem. Optimum orientation of units in a refinery for improved recovery and product specification is a problem that is now receiving attention.

E. **Quality Control.** The title of mathematical engineering might be interpreted to imply the use of more sophisticated methods than are actually practiced. Many of our problems are simple arithmetic and (if it were not for their volume) could be solved without difficulty. Heat and material balances around units and entire plants are typical of the routine problems that confront the operating engineer. Molar analyses are obtained from the peak readings of a mass spectrometer only after the solution of a set of linear simultaneous equations. Infrared analyses require the repetitive solution of a similar set of equations. The pilot plant or commercial plant engineer is always searching for correlations of his data, and statistical methodology is characterized by its simplicity simultaneously combined with an overwhelming volume of arithmetic. It is in this area that the habit of solving problems systematically is extremely important. Those who work with computers rapidly acclimate themselves to this necessity for restating many diverse problems on a more generalized, common basis.

II. Equipment Requirements

For the past three years, we have operated a card programmed calculator on two shifts in the research and development department. Since this machine is one of the first computers to be mass produced for scientific uses, it is also one of the easiest to operate and program. Ours was a very successful experience . . . during the entire three years, we averaged less than five per cent downtime for machine maintenance and absolutely no downtime due to the lack of problems. As we grew in experience, our "customers" from all departments grew in number. With this increasing backlog of problems and confidence, we ordered and have just recently placed in operation a larger, so-called medium-sized computer. Since many readers may not be familiar with the equipment required to solve the variety of problems given in the preceding section, a brief description of our installation follows.

A. **Main Computer.** Our computer is an internally programmed, electronic, magnetic drum computer. It has a memory (magnetic drum) capable of storing 4080 words (10 digits plus sign). These words are either the data on which the machine operates or the commands that it obeys. Some 54 internal commands are available and these include all of the arithmetic functions and many logical operations such as sign test, zero test, shift right or left, etc. In addition, subroutines sorted on the drum permit the use of auxiliary commands that cause the machine to take roots, compute logarithms, or evaluate any of the common trigonometric functions. The machine's normal mode of operation is in fixed decimal arithmetic but, again, subroutines make it possible to solve problems in which the numbers vary from 10^{-50} to 10^{50}. Most operations require about 2 milliseconds to complete; some of the more complicated functions require from 50 to 200 milliseconds.

FIG. 1. The magnetic drum computer, discussed in this article.

B. **Input and Output Channels.** Our computer operates with keyboard, paper tape, and card input with paper tape, card, typewriter, and line printer output. Our normal method of using this variety of channels is as follows: (a) The "algebra" of the problem (the program) is read into the machine on paper tape; (b) if necessary, minor changes are made on the drum by the operator at the keyboard; (c) specific data pertaining to the case at hand are called for from cards; (d) a detailed listing of the answers is printed out by the relatively fast line printer, and (e) a summary of the results, with alphabetical interpretation, is typed out by the relatively slow electric typewriter. Frequently, the typewriter is used to print out operator instructions only and the finished answers are left to the line printer.

C. **Data Communications Network.** Since we are operating an engineering computing facility for the entire company, the problems of communications are extremely important. Most of our problems are stated to us orally and, if they have already been analyzed and coded for the computer, the data are entered onto prepared forms. These forms are complete in every detail . . . from a description of what the machine routine can compute to specific instructions for the operator. For those problems that originate at other physical locations, we depend on teletype, telephone, and a data transceiver. For example, a complete data transmission system is now in operation between one of our mass spectrometer laboratories and our machine computations laboratory. Via an analog to digital converter, results from a mass spectrometer are automatically converted into punched card form. These peak readings with their calibration identification are transmitted to our computing laboratory by the transceiver and are there received in new punched cards. These latter cards are used in the computer and the answers (on punched cards) are relayed back to the point of origin. Although there are almost 500 miles between the terminals of this link, results (almost literally untouched by human hands) are returned in time to answer onstream operating problems in important plants.

D. **Space Requirements.** Our computing laboratory occupies a little over 1100 sq ft in our main offices. Although this room is somewhat crowded, we believe that there is still some space left for the additional equipment we will need to install later. Fig. 1 is a view of

FIG. 2. Data preparation and transmission area, with specialized staff at work.

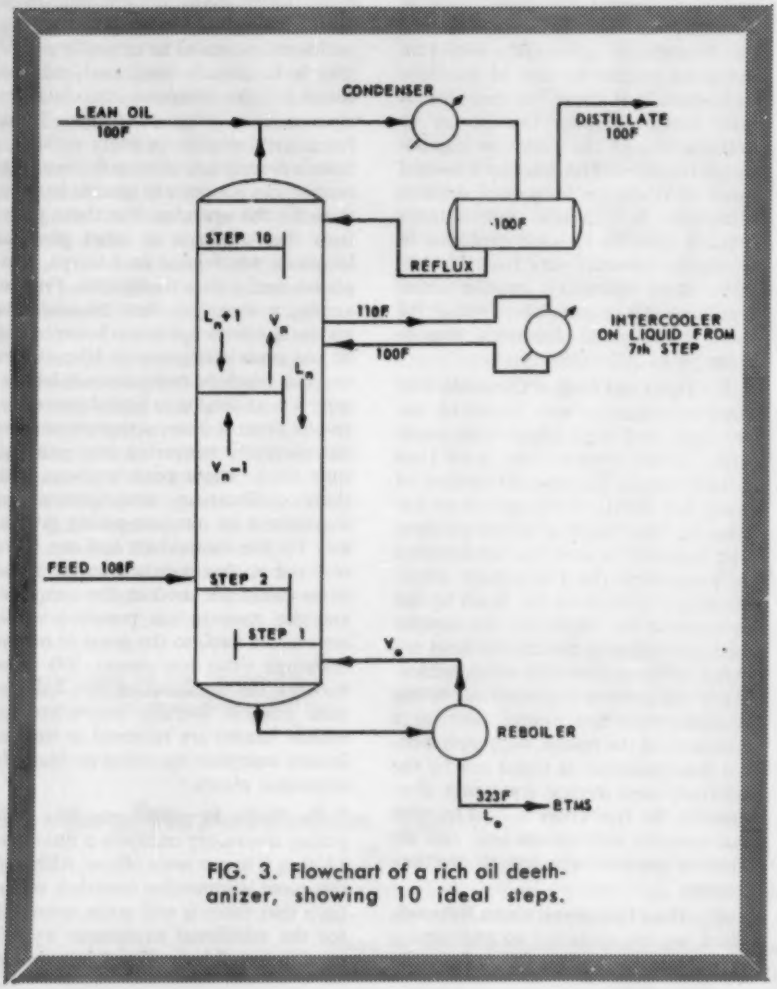

FIG. 3. Flowchart of a rich oil deethanizer, showing 10 ideal steps.

the computer with the operator's console in the foreground. Fig. 2 is a view of that part of the room which is devoted to data preparation and transmission. All engineering and mathematical aspects of analyzing, programming, and coding a problem for the computer are conducted outside the computing laboratory proper.

III. An Example in Process Design

As an example of the type of approach that is made to engineering problems, absorber design is fairly typical. The solution is a simple one involving no complicated mathematics. Since the machines operate rapidly and since coding a program for a machine is relatively time consuming, we have generally used as simple a program as possible.

Our operating departments give us many of their absorber design problems because these problems are usually more complicated and harder to estimate by short-cut methods than fractionators. The effects of inter-coolers, changes in vapor loading, and heavy components in the feed acting as an absorbent are difficult to guess without some sort of step-by-step solution.

A. Method of Solution. The machine takes much the same approach to absorber design that a man making a step-by-step solution would take. The overhead quantity and composition as well as the oil rate are estimated. It is then possible to calculate down the column to the stripping section in the case of reboiled absorbers or the column bottoms in the case of simple absorbers. This calculation is considered a single pass. After each pass, the computer calculates the ratio of the vapor to the feed step as calculated on the down-pass to the vapor from the stripping section as calculated on the up-pass. When these ratios equal unity, the column is solved. Until they are one, the computer keeps changing the estimated overhead and bottoms and making new passes.

This method of design assumes that the number of ideal steps and the oil rate have been set by the design engineer and the separation is to be computed. This is the easiest problem for the machine to solve since the fraction of any one component absorbed is a constant or almost a constant from one pass to the next. Thus the machine can easily guess a new overhead based on the absorbing factors in the preceding pass. However, the most common problem is to determine the required oil rate when the number of ideal steps and the separation are fixed. At present, the separation is determined at

several different oil rates until the best one is found.

Each individual pass is based on the following steps:

1. Estimate overhead vapor composition, and quantity.

2. Estimate absorbent oil rate, composition, and temperature.

3. Guess the temperature of the top ideal step.

4. Based on this temperature, calculate the composition in the liquid on the top step for the components other than the absorber oil,

$$x = \frac{y}{K}$$

5. $1-\Sigma x$ of the lighter components equals x of the oil.

6. Total liquid from the top step equals the oil flow divided by the concentration (x) of the oil. In most of our problems, the oil can be considered non-volatile.

7. The amount of each of the lighter components in the liquid from the top step can then be calculated by multiplying the mol fractions in the liquid by the total mols of liquid.

8. The composition and quantity of the vapor from the next lower ideal step can then be calculated by a material balance.

9. Now that all of the material in and out of the step has been calculated, a heat balance can be made if the temperature on the step below is known. Fortunately, the column calculations are not sensitive to this temperature. On the first pass, the next lower step is estimated a few degrees warmer than the tray being calculated. (The temperature of these steps cannot be obtained by a dew point calculation since the temperature is very sensitive to errors in the small amount of oil in the vapor). On all passes after the first, the temperature on the lower step is estimated from results of the preceding pass. These guesses usually prove to be accurate to within half a degree on the second pass. This heat balance indicates the amount of error in the guess of the top-step temperature. If the heat does not balance, the machine will guess a second temperature several degrees higher. From the heat balance obtained on this second temperature guess, the computer extrapolates the results and guesses a third temperature, which usually does satisfy the heat and material balances.

10. At this point, the liquid falling to the second step is completely specified and the composition and quantity of the vapor rising from that step is set. The computer returns to item 3,

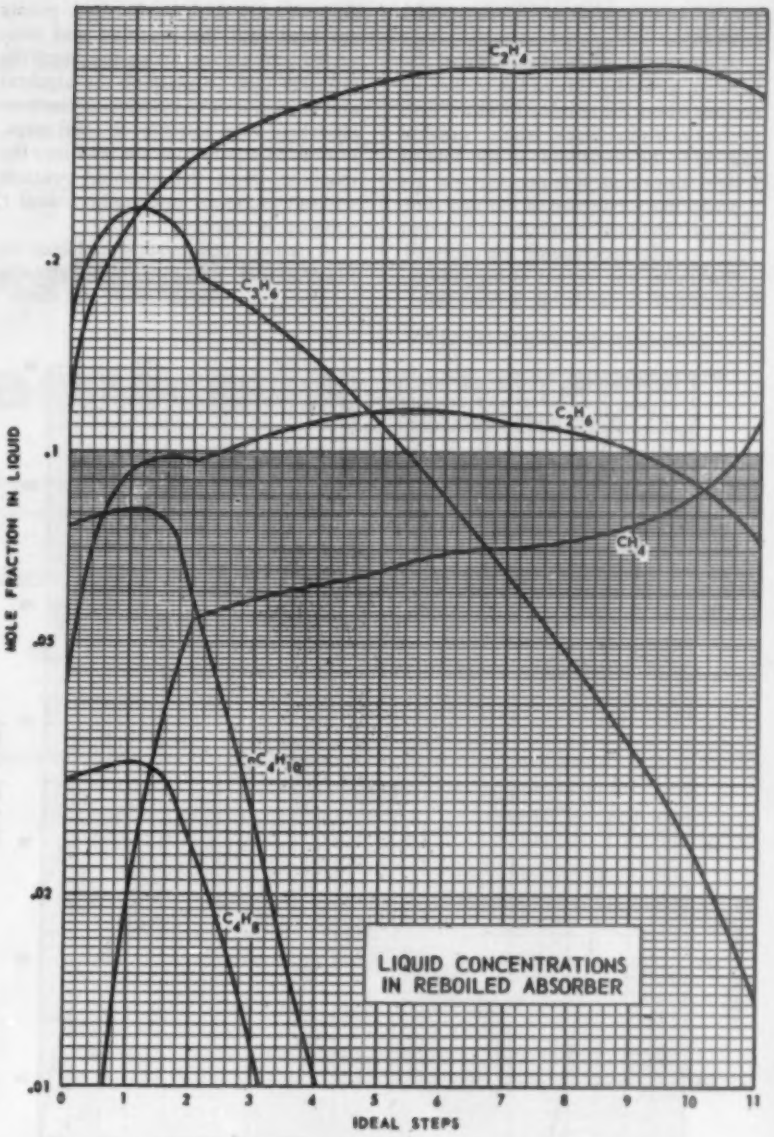

FIG. 4. Curves showing liquid concentrations in a reboiled absorber.

B. Absorber Example

Table 1

(1) Reboiled Absorber Specifications

	Feed (mols)	Absorbent (mols)
Hydrogen	0.40	0
Methane	10.09	0
Ethylene	17.80	0
Ethane	5.17	0
Propylene	12.26	0
Butenes	2.31	0
Butanes†	5.94	0
Mineral seal oil	34.00	13.0
Total	87.97	13.0

Feed temperature	106 F
Per cent vapor in feed	0 per cent
Pressure	800 psi
Condenser temperature	100 F
Lowest intercooling temperature	100 F
Steps in stripping section	2
Steps in absorbing section	8
Reboiler	1
Condenser	1
Total ideal steps	12

(2) Calculated Results

	Overhead (mols)	Bottoms (mols)
Hydrogen	0.40	—
Methane	9.78	0.31
Ethylene	11.23	6.57
Ethane	1.74	3.43
Propylene	0.19	12.07
Butenes	—	2.31
Butanes†	—	5.94
Mineral seal oil	—	47.00
Total	23.34	77.63

Condenser duty	49 M Btu
Intercooler duty	18 M Btu
Reboiler duty	1432 M Btu
Feed enthalpy	546 M Btu
M.S.O. enthalpy	80 M Btu
Overhead enthalpy	160 M Btu
Bottoms enthalpy	1831 M Btu
Boil-up ratio (Vo/Lo)	1.08
Reflux ratio (R/D)	1.29

above, and continues on down the column.

Assumption of a non-volatile absorbent is usually safe in the absorbing section where the temperatures are low, particularly in cases where mineral seal oil is the absorbent. In the case of a light absorbent, it is necessary to get a preliminary estimate of the step temperature and then recalculate the vapor based on the presence of the oil.

To make the actual computations, the enthalpy and equilibrium points are read into the machine and converted into curves. After this step, the program tape (containing the algebra) and the column specifications (such as absorbent rate, number of ideal steps, or desired separation) are read into the machine. Then the machine operates without technical intervention until a solution is reached.

A rich oil deethanizer was chosen for illustrational purposes although this particular design does not necessarily represent the most economical method of making the desired separation. Preceding this rich oil deethanizer, there is a simple absorber, and this absorber bottoms product is to be partially deethanized in the example reboiled absorber shown in Fig. 3. Specifications and results are given in Table 1. The specifications included number of stripping and absorbing steps, lean oil rate and composition, pressure, use of a condenser and one intercooler, condenser, feed and intercooler temperatures, and a general idea of the desired split. From these data, the machine computed the column split, a heat balance, a temperature gradient, and vapor and liquid concentrations and rates for every step in the column. The liquid concentrations on each step were plotted on Fig. 4. The vapor load and temperature on each step are plotted on Fig. 5.

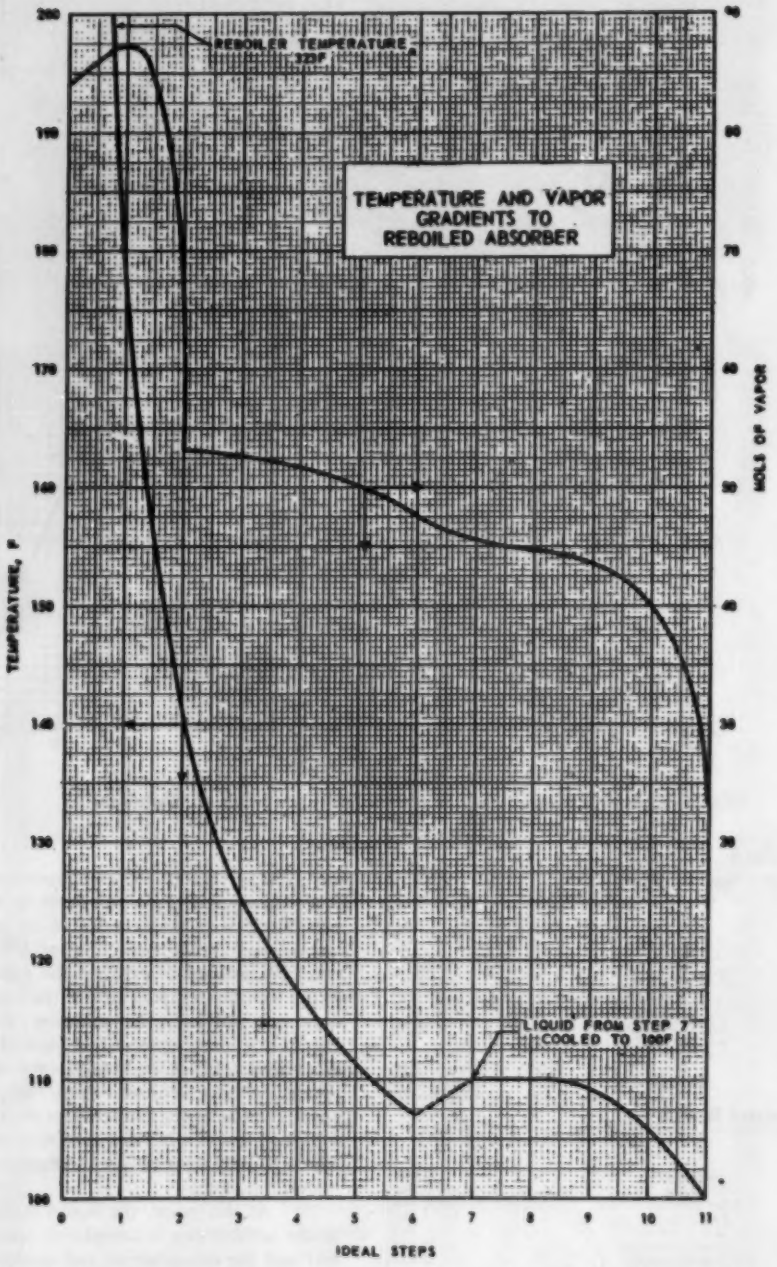

FIG. 5. Temperature and vapor gradients in a reboiled absorber, showing relationship of temperature to "ideal" steps.

This description should give some idea of the information that can be obtained with the automatic computer. Note that in this case the column has been assumed to be adiabatic. As a matter of fact, the computer can easily solve absorbers where losses are known to occur. Other refinements of this computational method are possible, and we have, in certain cases, solved columns with two liquid phases and with non-ideal volatility relationships.

IV. Conclusions

Advantages of using computers that we have found are as follows:

A. **Precision.** The machine can calculate problems that a man working with a slide rule could never solve because of low precision.

B. **Reserve Help.** The machine group forms an effective reserve to help design and operating groups throughout the company that find themselves temporarily overloaded.

C. **Speed.** The ability to get a good answer quickly is often very valuable in terms of increased production or quicker construction.

D. **Morale.** The computer frees the design groups from the tedious calculations and allows them to give more thought to the overall design, which most engineers prefer. At the same time, individuals in the computing organization proper are continuously challenged by a wide variety of difficult and intriguing problems that must be analyzed.

V. Acknowledgment

The authors wish to thank the research and development department of Phillips Petroleum Company for permission to publish this paper. ★ ★ ★

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The Oxo process opens a whole new synthesis field; oxygenated petrochemicals

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Earlier installments of this important series have appeared as follows:

May, 1955, page C-53. June, 1955, page C-13. July, 1955, page C-25. Nov. 1955, page C-41. Dec. 1955, page C-14. Jan. 1956, page C-33.

The concluding chapters will follow in later issues.—*Editor.*

Products of the Oxo Process

A wholly new process was introduced to American petrochemical technology in 1949, when Esso Standard Oil Company began Oxo operations at its Baton Rouge plant. Since that time five other producers have entered this field actively, and several other firms have made exploratory moves in this direction.

Most recent entrant into the field is Carbide and Carbon Chemicals Company which has recently begun operation of a commercial Oxo unit for the production of 60,000,000 lb per year chemicals at its Texas City plant. Initial operation will be directed to the production of isooctyl alcohol, and primary tridecyl alcohols. Prior to entering this full-scale venture, Carbide had been producing seven Oxo chemicals at pilot plant facilities at South Charleston, West Virginia.

Other manufacturers following the Oxo route are Esso Standard Oil Company, Standard Oil Company (Indiana), Gulf Oil Corporation, and Tennessee Eastman Company. At its Belle, West Virginia, plant, DuPont has employed oxoation for the production of trimethyl hexanol from di-isobutanol. This operation has, however, been discontinued.

This new unit process, the Oxo synthesis, involves the simultaneous reaction of carbon monoxide and hydrogen (synthesis gas) with an olefin to yield an aldehyde containing one more carbon atom than the hydrocarbon feedstock:

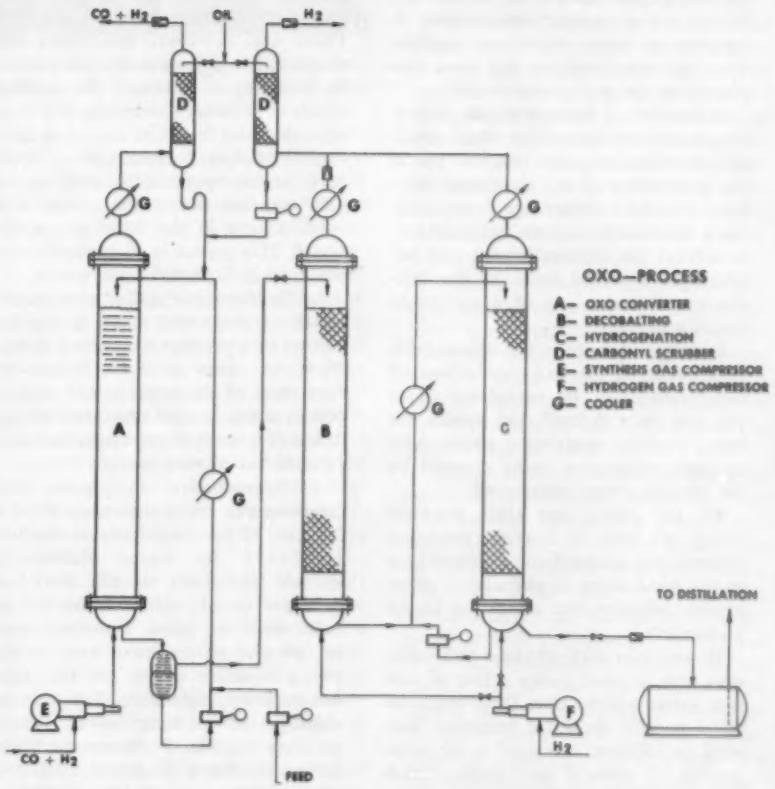
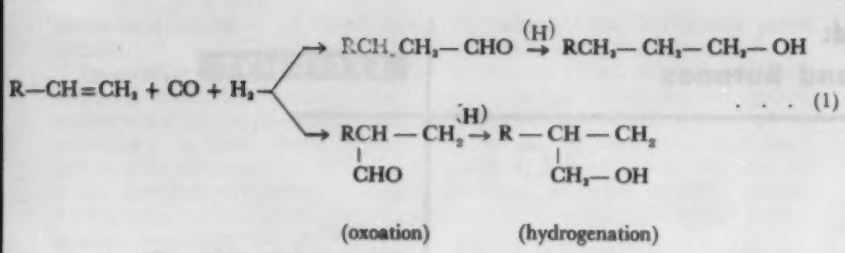


FIG. 1. One version of the Oxo Process — Courtesy Blaw-Knox Co.



(oxoation) (hydrogenation)

Tennessee Eastman Company's Longview, Texas, plant uses this process to convert propylene to n-butyraldehyde, isobutyraldehyde, and the corresponding alcohols. All other manufacturers in this field operate with olefins of higher molecular weight. Of direct interest to the present discussion is the production of trimethyl hexanol (from the dimer of isobutylene) and tridecyl alcohol (from dodecene, the tetramer of propylene).

N-butyraldehyde finds important utilization as intermediate in the production of butyric acid and its anhydride, which are used extensively in the manufacture of cellulose butyrate and of mixed esters such as cellulose acetate butyrate. Another n-butyraldehyde use is its reaction with polvinyl alcohol to form polyvinyl butyral. PVB is employed extensively as an interlayer for safety glass as well as for coating fabrics and in lacquer formulations. A number of other significant applications for this aldehyde has been discussed by the writer elsewhere[1].

N-Butanol, a butyraldehyde derivative, is a useful solvent for urea-formaldehyde resins, etc., and raw material in the production of the plasticizer di-n-butyl phthalate. Other significant n-butanol derivatives include butyl acetate (a solvent for nitro-cellulose) and butylamines (intermediates in the production of resins and of a variety of flotation agents).

Isobutyraldehyde is an unavoidable by-product in the oxo production of n-butyraldehyde. Its usefulness is, as yet, less fully defined, but strides are being made in applying it successfully to applications now being covered by the straight-chain compound.

Of the other two Oxo products which are here of interest, trimethyl hexanol has attained some importance in the production of phthalates, phosphates, adipates, etc. which are useful plasticizers.

By reaction with ethylene and sulfation, this alcohol yields a line of surface active agents. Uses for tridecyl alcohol parallel those for trimethyl hexanol. In addition, it is used in the preparation of tridecyl mercaptan, which figures in GR-S rubber manufacture.

Although the Oxo reaction proper leads predominantly to aldehydes, separation difficulties deny the use of the process for the direct synthesis of aldehydes, which have more than five carbon atoms. Application of the process to compounds of higher molecular weight is therefore confined to the production of alcohols, which means that the primary Oxo aldehydes are directly hydrogenated without interim separation. Because of their greater stability, the product alcohols may be successfully separated.

The Oxo reaction is carried out in the liquid phase in every commercial instance. The controlling variables are catalyst, operating pressure and temperature and, to a more limited extent, the suspension medium.

1. *Catalyst.* An active form of cobalt is universally employed in the Oxo reaction. Some commercial work has been carried out with conventional Fischer-Tropsch cobalt catalyst (30 per cent Co, 2 per cent thoria, 2 per cent magnesia, 66 per cent kieselguhr). There are, however, indications that magnesia is objectionable because of its tendency to promote the condensation of product aldehydes, and magnesia does not therefore appear in more recent catalyst formulations. Copper may be incorporated to stabilize cobalt, and thus reduce the extent of its volatilization in the form of its carbonyl. This aspect is of particular importance in fixed-bed catalysis.

In the absence of sulfur compounds, cobalt catalysts will result in the formation of a product containing at least 20-40 per cent alcohols. Where the formation of aldehydes rather than alcohols is the desired objective, the addition of a small amount of sulfur compounds has proved useful.

2. *Temperature.* In general, Oxo temperatures are in the range 100-145 C (100-115 for conversion of ethylene, 120-145 C for higher olefins). To operate effectively in this low temperature range, active forms of cobalts such as those described must be employed (almost any cobalt salt is effective above 150 C.) Low-temperature operation has the advantage of making lower system pressure feasible. Furthermore, higher olefins exhibit a tendency to double-bond isomerization at Oxo conditions, and this objectionable side reaction may be minimized by operating at the lowest feasible temperature.

The Oxo reaction is not particularly temperature-sensitive. It is therefore possible to maintain the temperature differential between coolant and reaction phase as large as 20 C. This is of great significance in the light of the large heat evolution which accompanies the Oxo synthesis (Approximately 50,000 Btu/lb mole olefin; as high as 62,500 Btu for ethylene).

3. *Pressure.* While the Oxo reaction can theoretically proceed at atmospheric pressure, the need to prevent decomposition of the effective catalyst (dicobalt octacarbonyl), calls for partial pressures of carbon monoxide in excess of 40 atmospheres (at 150 C). Accordingly, the Oxo reaction is generally run at system pressures in the range of 100-250 atmospheres.

In certain cases, pressure has limited influence on the composition of the product. Propylene conversion at 100-250 atm yields n-butyraldehyde and isobutyraldehyde in the ratio 4:6. Boosting the system pressure to 700 atm reportedly favors formation of the normal aldehyde, which accounts at such conditions for 75 per cent of the isomeric product.

4. *Miscellaneous Operating Variables.* Synthesis gas employed for the Oxo reaction is generally composed of equal volumes of carbon monoxide and hydrogen. In the oxoation of gaseous olefins, the hydrocarbon is introduced with the synthesis gas in approximately stoichiometric ratio.

Where liquid olefins are oxoated, the feedstock itself is used as suspension medium for the catalyst (in the slurry process to be discussed below). Complete olefin conversion is taken in a single pass. Synthesis gas, on the other hand, is introduced in excess (where liquid olefins are the raw material) and must be recycled.

In the Oxo synthesis with gaseous olefins, an auxiliary suspension medium must be employed. Usually an inert hydrocarbon is selected which differs in boiling point sufficiently from the resulting aldehyde to permit ready separation. Good results have been reported in the synthesis of water-soluble aldehydes (such as propionaldehyde) by the use of an aqueous suspension phase. The chief drawback of this approach rests in the difficulty of purifying the aldehyde from its dilute aqueous phase.

Technology of Oxo Synthesis

Two versions of the Oxo process have come into commercial operation. The techniques differ chiefly in the means used for contacting catalyst with reaction medium. The older system provides cobalt catalyst as a slurry in the feedstock (or auxiliary suspension medium). More recently, fixed-

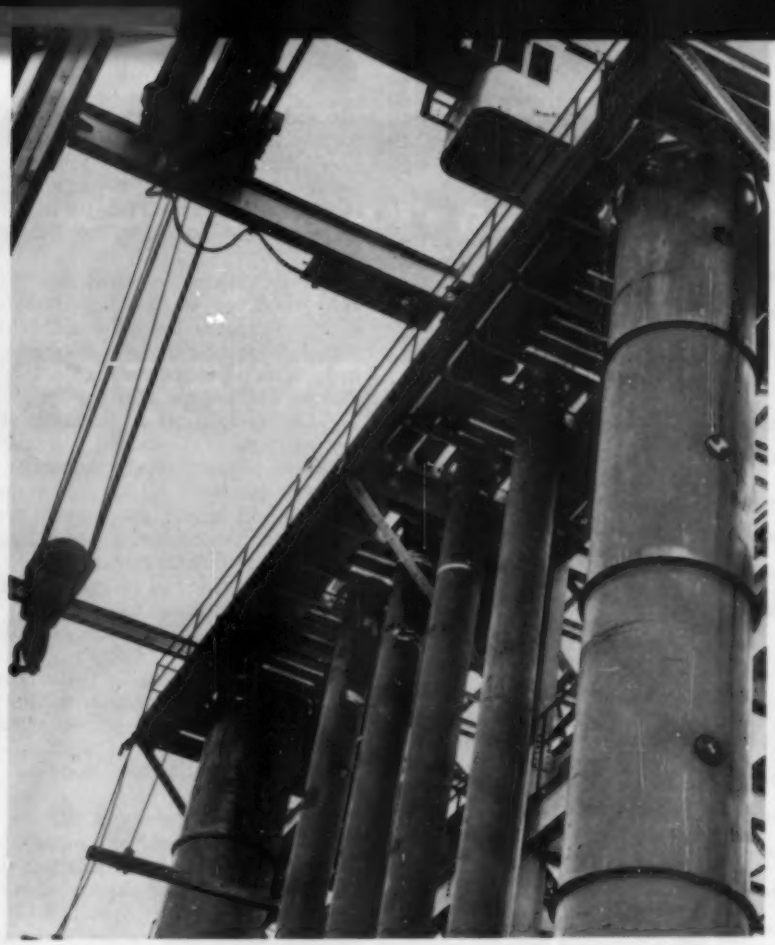


FIG. 2. The heart of the Oxo process is in the high pressure catalytic reactors; the plant shown here, operated by Texas Eastman Company produces normal and isobutyraldehyde.

bed processing has come to the fore. The newer method eliminates the need for filtration and some solids handling which is associated with the slurry-type process.

If alcohol is the desired end product, the Oxo stage must be followed by a hydrogenation step. It is not now feasible to carry out these two operations in a single step. The high carbon monoxide content required for the hydroformylation (Oxo) reaction interferes with the hydrogenation reaction. In this connection, however, interest attaches to recent work by Wender et al[2] in which the reduction of aldehydes was carried out effectively in the presence of CO by the use of higher temperatures (approximately 180 C). A brief process description will bring out highlights in the two basic techniques applicable to commercial oxoation.

In the slurry-type process, the charge stock is mixed with 3-5 per cent catalyst. Most of this catalyst is recycle material; make-up requirements are small. The resultant slurry is boosted to reaction temperature and pressure (150 C, 225 atm) and is fed to the bottom of a primary reactor which it enters concurrently with a stream of synthesis gas with a carbon monoxide : hydrogen ratio of 1.0. Typically, about two-thirds of the gas is a recycle stream, the remainder being make-up.

About 70 per cent of the conversion takes place in the first reactor. The reaction is taken to completion in a secondary Oxo converter. The use of two reactors in series has the advantage of minimizing backmixing and of permitting speed-up of reaction rate in its final stages by operating the second converter some 10-20 C above the firs: 2 min, and it is at this stage to the bottom of the second reactor, which is also operated in concurrent fashion.

Total contact time is of the order of 20-30 min. About one-third of the total reaction takes place during the first two minutes, and it is at this stage that cooling requirements are the most critical. Either cooling tubes or external heat exchangers may be used to cover this need.

The reactor effluent leaving the top of the second reactor is separated from the gas phase in a knock-out drum. With the exception of a small bleed-stream, the gas is recycled to the reactor system via a gas cooler.

The crude Oxo make is released to atmospheric pressure before it is fed to the hydrogenation stage (to produce alcohols, if this is the desired objective). This venting is necessary to strip the slurry of contained carbon monoxide and to remove or decompose contained cobalt carbonyl which interferes with the hydrogenation reaction (on cobalt catalyst).

If the olefinic feedstock is sulfur-free, the use of the Oxo catalyst itself is feasible for hydrogenation purposes. Alternately, a standard copper chromite hydrogenation catalyst may be used after the removal of the cobalt compounds from the slurry. Such "decobalting" may be effected by an intermediate partial hydrogenation stage in which cobalt is reduced to the insoluble, and therefore filterable metallic form.

The slurry technique of hydrogenation in the presence of cobalt catalyst parallels the Oxo flow described above. The reaction is carried out at 200-250 atm and 170-180 C under substantially pure hydrogen pressure. To eliminate residual carbon monoxide, which tends to accumulate in recycle hydrogen, the recycle stream is subjected to methanization over iron catalyst before it is returned to the main converters.

The crude hydrogenated slurry, after separation from the gas phase, is freed of suspended catalyst by filtration. The alcohols must be separated from hydrocarbons, and frequently from each other, by distillation. This presupposes that a fairly pure olefinic feedstock has been employed. The Oxo conversion of wide fractions leads to highly complex mixtures which defy separation by economic means.

Fixed-bed catalysis in the Oxo process has the advantage of eliminating catalyst filtration and some solids handling. Difficulties in such a system are low space velocity and deterioration of fixed-bed catalysts caused by the formation of alcohol-soluble and volatile cobalt carbonyl.

In one approach, which has attracted attention, the catalyst consists of 2 per cent metallic cobalt on a pumice carrier. To make up cobalt losses, this metal is introduced with the olefinic feedstock in the form of the soluble salt of a fatty acid. The olefinic charge, together with synthesis gas ($CO:H_2 = 1.0$) in considerable excess, is fed to the top of the Oxo reactor. The liquid effluent is separated from the gas phase and is fed to a partial hydrogenation (decobalting) converter for the destruction of dissolved cobalt carbonyl. The treatment is carried out in the presence of hydrogen at 200 atmospheres and at approximately 120

C. Metallic cobalt is deposited on pumice with which the reactor is packed.

Fixed-bed Oxo processes do not permit the use of primary catalyst for the hydrogenation stage. A separate hydrogenation catalyst (e.g. copper chromite) is employed for this purpose.

Products of Alcohol Oxidation and Dehydrogenation

(a) Aldehydes

Of the eight commercial methods of aldehyde synthesis, only one is useful for all members of the homologous series. This route is the oxidation and/or dehydrogenation of alcohols.

Within the scope of the present discussion, production of acetaldehyde from ethanol is the most important example, and this will be given closer scrutiny.

On a dry basis, the production volume of acetaldehyde exceeds that of all other aldehydes. Most of this production is captive, and only a small portion enters trade channels as such.

1954 output of acetaldehyde in the U. S. is estimated at 700,000,000 lb. Of this, 420,000,000 lb are converted to acetic acid and anhydride, 200,000,000 lb enters n-butanol synthesis, 50,000,000 lb go to 2-ethyl hexanol production, and the balance to miscellaneous derivatives, including above all pentaerythritol, ethyl acetate, pyridines and chloral[2].

Of 10 American acetaldehyde plants, six use today ethanol as raw material — providing, incidentally, the largest single outlet for industrial alcohol. Chief competitive processes are direct oxidation of hydrocarbons, hydration of acetylene and (not currently in operation) by-products of gas synthesis.

Three methods are available for the conversion of alcohols to aldehydes: Straight oxidation, straight dehydrogenation, and combined oxidation-dehydrogenation. Only the two last-named are used for commercial synthesis of acetaldehyde. Straight oxidation, which figures in formaldehyde production is not used in the manufacture of acetaldehyde for reasons set forth by the author elsewhere[1].

Of the two commercial methods for conversion of ethanol to acetaldehyde, the straight dehydrogenation process is favored. Its chief advantages rest on greater ease of temperature control, the formation of by-product hydrogen, less product dilution, and simpler purification (due to much lower water concentration in the product). This route to acetaldehyde has been practiced in the United States since 1930. Underlying as reaction (2).

Dehydrogenation: $CH_3CH_2OH \rightarrow$

$$CH_3-C\begin{matrix}\nearrow O\\ \searrow H\end{matrix} + H_2 \quad \cdots \quad (2)$$

Copper is a highly specific catalyst for this reaction. By itself, however, it loses its activity readily, a tendency which may be overcome by incorporation of suitable promoters.

A feasible dehydrogenation process, due to Church and Joshi[4] is based on the catalytic use of supported copper containing 5 per cent cobalt and 2 per cent chromium. Asbestos serves as preferred carrier. Upon loss of activity, this catalyst may be regenerated to initial effectiveness by air oxidation (400 C) followed by reduction by alcohol at 280 C.

The endothermic reaction (600 Btu per pound alcohol converted) requires a constant supply of heat. The catalyst is therefore mounted in a tubular converter in indirect exchange with Dowtherm or similar medium.

Vaporized, preheated 95 per cent enthanol enters the catalyst bed which is maintained at 275-280 C. At this temperature and with a 90 per cent per-pass conversion of alcohol, acetaldehyde is formed in 85 per cent yield. Ten per cent of the charge alcohol is usefully converted to by-product ethyl acetate and five per cent is lost to diverse side reactions.

Church describes product recovery by sub-cooling the make gases to –10 C, but other means (e. g. absorption) may also be used. Standard fractionation methods serve to separate acetaldehyde from ethyl acetate, water, unconverted ethanol, and other associated materials (including scrubbing medium, if any).

By-product hydrogen, formed in this process, is of 98 per cent purity, and is a serviceable feed to hydrogenation operations.

Oxidation-Dehydrogenation of Ethanol

Straight oxidation of ethanol is not practiced. The method actually selected parallels closely the composite air oxidation — dehydrogenation method which serves in the synthesis of formaldehyde from methanol. Here, too, silver catalyst is employed.

Work by Faith and Keyes[5] indicates that the unsupported metal, largely because of its high heat conductivity leads to particularly good yields. Per-pass acetaldehyde yield over silver gauze showed a pronounced maximum of 80.6 per cent at 515 C. Actual per-pass conversion is, however, held below this value in order to minimize over-oxidation.

According to Shreve[6], the reaction is carried out commercially at 550-570 C with a per-pass conversion of 50-55 per cent and a yield of 85-95 per cent (this upper yield limit appears excessive and should probably be closer to 90 per cent). Using a feed ratio of 1 mole ethanol : 0.3 moles air (i.e. a 40 per cent initial alcohol concentration), Hsu[7] obtained acetaldehyde in 90 per cent yield over silver catalyst at 460 C.

The techniques employed for the conversion of ethanol to acetaldehyde serve also in the synthesis of propionaldehyde and the two butyraldehydes from the corresponding alcohols. Competitive sources exist (or are being developed) in direct oxidation of hydrocarbons, Oxo synthesis, and iron-catalyzed Fischer-Tropsch operations.

Propionaldehyde is, at present, a chemical of limited commercial acceptance. It is used as disinfectant and in the production of rubber accelerators. Various potential and actual uses parallel applications for its closest homologues acetaldehyde and butyraldehyde.

N-butyraldehyde finds important utilization as intermediate in the production of butyric acid and its anhydride. One of the most significant reactions of butyraldehyde is with polyvinyl alcohol to form polyvinyl butyral. PVB is used extensively as an interlayer for safety glass as well as for coating fabrics and in lacquer formulations. The self-condensation of two molecules of butyraldehyde and subsequent conversion to ethyl hexyl alcohol has assumed significance as a step in the production of the plasticizers trioctyl phosphate and dioctyl phthalate; condensation of butyraldehyde with phenol yields an important class of oil-soluble resins.

Markets for isobutyraldehyde are more confined. They are being developed along the lines of outlets for n-butyraldehyde.

(b) Ketones from Alcohols

The oxidative or dehydrogenative conversion of secondary alcohols leads to the important class of Ketones.

$$R-\underset{H}{\overset{OH}{C}}-R \rightarrow R\overset{O}{C}-R \quad \cdots \quad (3)$$

Within the scope of our present discussion, interest in this synthesis is confined to the manufacture of acetone and methyl ethyl Ketone. These incidentally, are by far the most important members of the ketone family.

Acetone production in 1953 was 523,000,000 lb. The proportion (but not the total volume) of acetone entering direct solvent use has receded during recent years and accounts today for some 30-35 per cent of total consumption. The remainder enters chemical synthesis as raw material. The following estimated consumer distribution applies:

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Diacetone Alcohol (intermediate in the production of mesityl oxide, methyl isobutyl ketone and carbinol, and of hexylene glycol)	Per Cent 52
Acetone Cyanhydrin	10
Ketene (for acetic anhydride)	20
Isophorone and Phorone	6
Miscellaneous	12

Methyl ethyl ketone, produced at an estimated rate of 200,000,000 lb per year finds by far its most important application as a solvent. The following distribution pattern has been estimated[7]:

	Per Cent
Nitrocellulose lacquers	38
Vinyl resin lacquers	37
Other resin coatings	2
Solvent dewaxing of lube oil	10
Rubber cements	5
Misc. (incl. chemical synthesis)	8

In the production of acetone from isopropyl alcohol, catalytic dehydrogenation is of principal interest:

$$CH_3-\underset{\underset{OH}{|}}{CH}-CH_3 \rightarrow CH_3-\underset{\underset{O}{||}}{C}-CH_3 + H_2 \quad (4)$$

The reaction is endothermic (15,900 calories/g-mole at 327 C). An alternate, exothermic conversion by partial oxidation is at hand.

Both reactions may be catalyzed effectively by catalysts of the same type (copper, nickel, zinc oxide, etc). The oxidation process has certain disadvantages including difficulty of temperature control and somewhat lower yield than can be obtained in straight dehydrogenation.

In the dehydrogenation reaction, the equilibrium shifts rapidly in favor of acetone formation as the temperature rises. According to Kolb[8], maximum possible conversion is 84 per cent at 225 C, and 97 per cent at 325 C. Above this temperature, theoretical conversion increases only very gradually until it is substantially complete at 525 C. In the highest temperature range, however, losses are encountered by the ascendancy of side reactions, of which dehydration of isopropanol to propylene is, at first, the most serious. For practical purposes, the operating range is therefore limited to 300-400 C.

In this temperature range, dehydrogenation of isopropanol is made feasible by the availability of highly active catalysts of excellent selectivity. While the range of catalyst covered for this reaction in the patent literature is large, only very few — notably those based on copper and on zinc oxide — offer attractiveness for industrial purposes.

In the production of acetone by dehydrogenation of isopropanol, the reaction stage alone determines the usefulness of the process. The effluent gases are cooled and scrubbed for the recovery of a liquid mixture containing 85-90 per cent acetone, the balance being predominantly isopropanol; standard fractionation and azeotropic distillative methods serve for purification of product ketone and recovery of recycle isopropanol in anhydrous form.

At one commercial acetone plant, the catalyst is 7-8 per cent zinc oxide on a pumice carrier. The mass is mounted in the tubes of a vertical shell-and-tube reactor. Heat is supplied by flue gases circulated through the shell at carefully controlled temperature. Before the catalyst is taken on stream, it is pretreated with air at 500 C.

To prevent premature catalyst fouling, hydrogen is mixed with isopropanol in equimolar ratio. The mixture, wholly in the vapor state, is fed to the top of the reactor tubes through which it travels. Operating temperature is 380 C. With fresh catalyst, 98 per cent of the feed alcohol is converted in a single pass — almost entirely to acetone, with some formation of propylene and diisopropyl ether.

After ten on-stream days, the extent of conversion has dropped to the point where catalyst regeneration becomes necessary. This is accomplished by circulating over it a mixture of 2 per cent oxygen and 98 per cent nitrogen at 500 C until carbon dioxide formation ceases (after 4-5 hours). Operation may then be resumed. Each batch of catalyst has an overall life of about six months before it must be replaced.

The product gases leaving the reactor are cooled and a portion of the acetone make is thereby condensed. A water wash removes residual acetone and unconverted isopropanol from the effluent gas stream (mainly hydrogen). Drying and purification is effected by standard fractionating techniques.

Production of methyl ethyl ketone from isobutanol takes a very similar course. Here, a more favorable equilibrium prevails in the low-temperature range (around 150 C). But, at practical operating temperatures, equilibrium conversion of isopropanol and of isobutanol is nearly the same.

Padovani[9] has examined numerous catalysts for the dehydrogenation of isobutanol. By far the best results were obtained with a promoted zinc oxide catalyst which had been impregnated with sodium silicate to suppress a light tendency to dehydration. The catalyst is regenerable by oxidative treatment followed by reduction. Padovani found that peak activity was obtained only after two or three regenerations. After this the optimum operating temperature was 320-330 C. With an LHSV of 0.6, per-pass conversion was 75-80 per cent, and ultimate yield was 96-97 per cent. Tail gas contained no more than 0.5 per cent olefin, thus indicating satisfactorily small degree of dehydration.

5. Alternate Routes to Acetone

It is our purpose here to consider the means of synthesizing industrial petrochemicals starting from ethane, propane, and butanes.

In addition to its production by isopropanol dehydrogenation, acetone may be obtained from C_3-hydrocarbons by three noteworthy methods. One of these, the direct oxidation of lower aliphatic hydrocarbons, has been considered in Part IV of this series. The other two, involving the peroxidation of cumene and isopropanol, respectively, have attained commercial significance during the last three years, and will be discussed in the following section.

Acetone via cumene — an outstanding contribution to petrochemical technology has been a novel process for the simultaneous production of tar acids and ketones from alkylated aromatics. The process made its industrial debut in May, 1953, at B. A. Shawinigan, Ltd.'s plant in Canada. In the United States, it is employed by Oronite Company, Barrett Division, and Hercules Powder Company.

All of these firms start with cumene to produce phenol and acetone. In addition, Hercules Powder Company derives cresol and acetone from methyl isopropyl benzene, and plans to extend operation of the process to the manufacture of resorcinol and of hydroquinone.

The multi-fold commercial application by Hercules Powder Company of this new synthesis illustrates the wide potential range of operation for the process. Indeed, the process may be employed successfully for the manufacture of a range of tar acids with the concomitant production of acetone, methyl ethyl ketone, or some other aliphatic ketones. Economics of the process (for phenol production) is predicated on a fair return for by-product acetone, and it is here that foreseeable overproduction creates possible danger.

The present discussion will be confined to the method as it is applied to its most important products, phenol and acetone.

Cumene, the starting material in this process is the alkylation product of

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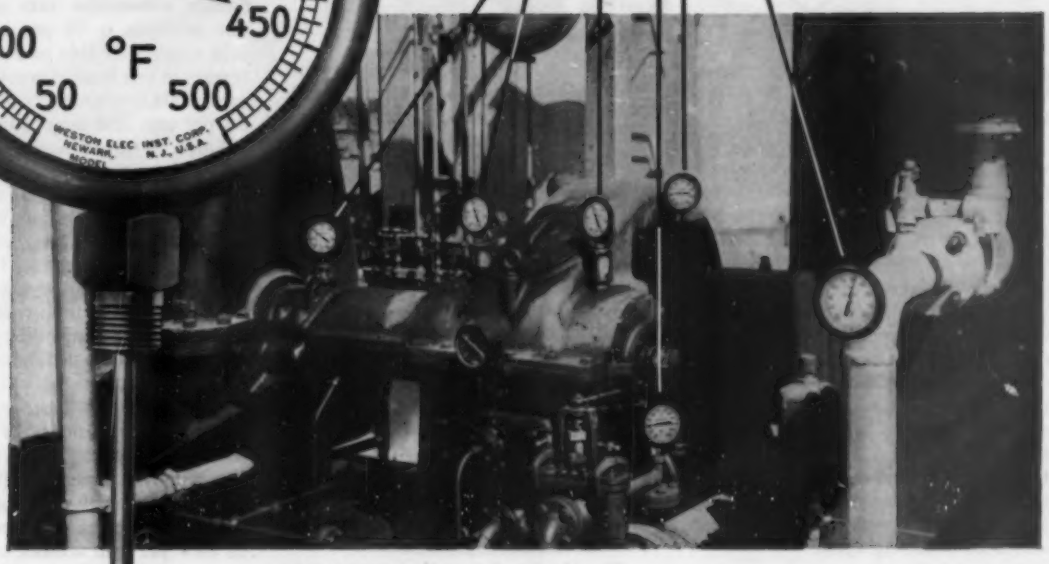

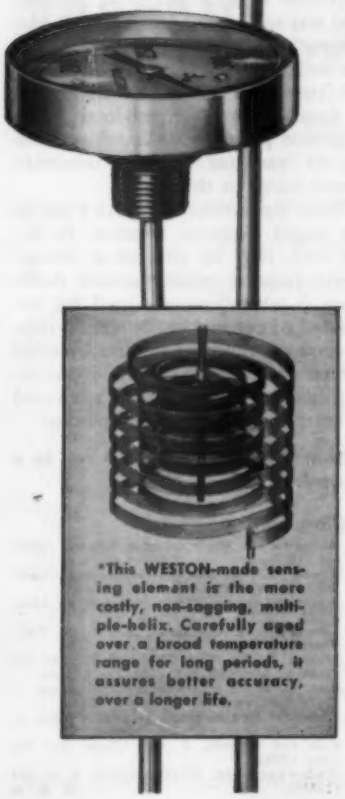
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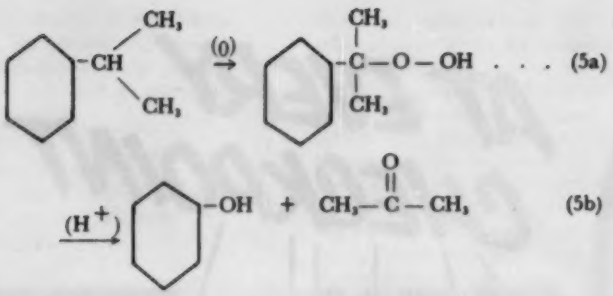

propylene and benzene. Its synthesis has been discussed in Part II of this series.

Two distinct chemical steps are involved in the conversion of cumene to phenol and acetone: (a) Autoxidation of the hydrocarbon to cumene hydroperoxide, which is then subjected to (b) cleavage into phenol and acetone.

(a) Autoxidation of Cumene

Two industrially feasible techniques have been developed for the peroxidation of cumene. One of these methods carries out the oxidation reaction in a dispersion of the hydrocarbon in slightly alkaline aqueous phase. An alternate approach calls for proper pretreatment of dry cumene and its oxidation in the presence of copper catalysts. In both methods, air or purified oxygen serves as oxidizing agent.

In the emulsion process for cumene oxidation, the controlling variables are pH, intimacy of contact and volume ratio between the phases, and operating temperature.

For satisfactory conversion rate and yield, it is necessary that the pH be held between 8.5 and 10.5, a condition which can be readily maintained by the use of sodium carbonate as buffer.

An emulsifying agent must be employed in conjunction with thorough stirring. The choice of emulsifying agent influences the reaction progress significantly. Sodium stearate, employed in this function, promotes good oxygen absorption rate.

Increasing the water : hydrocarbon ratio results in improved oxidation rate. Good oxygen absorption is obtained at volumetric ratios above 3:1.

Relatively mild conditions (85 C, atmospheric pressure) are maintained in this version of the process. Although air may be employed as oxidizing agent, the use of oxygen offers the advantage of higher partial pressure and consequent improvement in reaction rate in this heterogeneous system.

Hydroperoxide yield is almost quantitative during the early stages of reaction. As the concentration of peroxide in the system increases, a portion of it is destroyed by further oxidation, resulting in an overall yield reduction. At 20 per cent hydroperoxide, yield is of the order of 90 per cent. Up to 45-50 per cent conversion is possible before degradation reactions make excessive inroads on yield. For practical purposes, however, conversion is held in the range 25-40 per cent.

The reaction is initiated by the presence of peroxide and an incubation period can be avoided by introducing some cumene hydroperoxide with the feed. Retardation or even complete inhibition is caused by a number of impurities, among them phenol, styrene, and alpha-methyl styrene.

Without intervening purification, the crude oxidation product may serve as direct feed to the cleavage reaction system, where contained cumene hydroperoxide is converted to acetone and phenol.

The "dry" technique for cumene oxidation parallels, in its fundamentals, the aspects of the emulsion process. However, actual method of execution differs sufficiently to make this a distinct method.

In this autoxidation process, the reactor is a vertical packed tower. Because of its catalytic and stabilizing effect, copper is used for the packing as well as for the reactor wall in contact with the reaction phase.

Air or oxygen enters the converter concurrently with the hydrocarbon feed. No special cooling provision need be made to handle the mildly exothermic reaction (approximately 182 Btu per pound cumene hydroperoxide formed).

As in the wet process, the presence of phenol and α-methyl styrene are very harmful. The reaction is completely inhibited by the presence of thiophenol and isopropyl thiophene, both of which may occur in the charging stock. Pre-treatment of the hydrocarbon feed by thorough sulfuric acid washing is indicated for the removal of these harmful contaminants.

In "dry" oxidation with copper catalyst, 120 C is the preferred operating temperature. Rate of hydroperoxide formation is 11-12 per cent per hour, and yield is of the order of 93-97 per cent of theory.

Conversion to acetone and phenol. Regardless of oxidation process employed, the crude organic product may be subjected to cleavage (Reaction 5b) without intervening purification.

A variety of acids may be used as effective cleavage promoters. Dilute sulfuric acid, as well as gaseous sulfur dioxide answer the demands of the process well and are the preferred media.

In sulfuric acid — catalyzed cleavage, acid concentration is found to influence conversion rate significantly. For example, a 10 per cent sulfuric acid solution is able to complete conversion in one hour at conditions which necessitate five hours contact time with a 1 per cent acid concentration.

Since, in this version of the process, the reaction system consists of two heterogeneous phases, the efficiency of stirring is of significant influence on reaction progress. The yield is largely influenced by operating temperature. Certain mechanical advantages are obtained, though at the expense of yield, by operating at the boiling point of the mixture, thereby facilitating overhead removal of acetone as it is formed.

The effect of hydroperoxide concentration on efficiency in **SO_2 — promoted cleavage** has been studied in a film-type contactor at approximately 20 C. A 28.7 per cent content of hydroperoxide in cumene led to a yield of 84.4 per cent acetone and 93.3 per cent phenol. By raising the feed concentration to 42.2 per cent, acetone yield was reduced to 68.5 per cent and a phenol yield of only 90.6 per cent was obtained.

Acetone and cumene can be topped off from the reaction products. Neutralization prior to distillation and the use of vacuum topping minimize phenol losses in this stage.

These separations are carried out in two stages. Acetone removal, in the first step, may be effected at atmospheric pressure while vacuum distillation is advantageously used for the removal of cumene in the second step. By-product acetophenone and α-methyl styrene are contained in the hydrocarbon fraction and both are recovered by at least one commercial operator.

Section 2 of Part V will be run in a succeeding issue.

Bibliography

1. Sherwood, P. W., Petroleum Refiner, January, 1955.
2. Wender, Levine, and Orchin., J. Am. Chem. Soc. *72*, 4375 (1950).
3. Anon. Chemical Week, October 9, 1954, p. 93.
4. Church, J. M. and Joshi, H. K., Ind. Eng. Chem. *43*, 1804 ff. (1951).
5. Shreve, R. N., The Chemical Process Industries, McGraw-Hill Book Co. (1945).
6. Hsu, C. M., J. Toiwan Pharm. Assoc. *1*, 11-24 (1949); C. A. *46*, 425 (1952).
7. Chemical Engineering, February, 1955, p. 275.
8. Kolb and Burwell, J. Am. Chem. Soc. *67*, 1084 (1945).
9. Padovani; Riv. Combustibili, *5*, 81-144 (1951).

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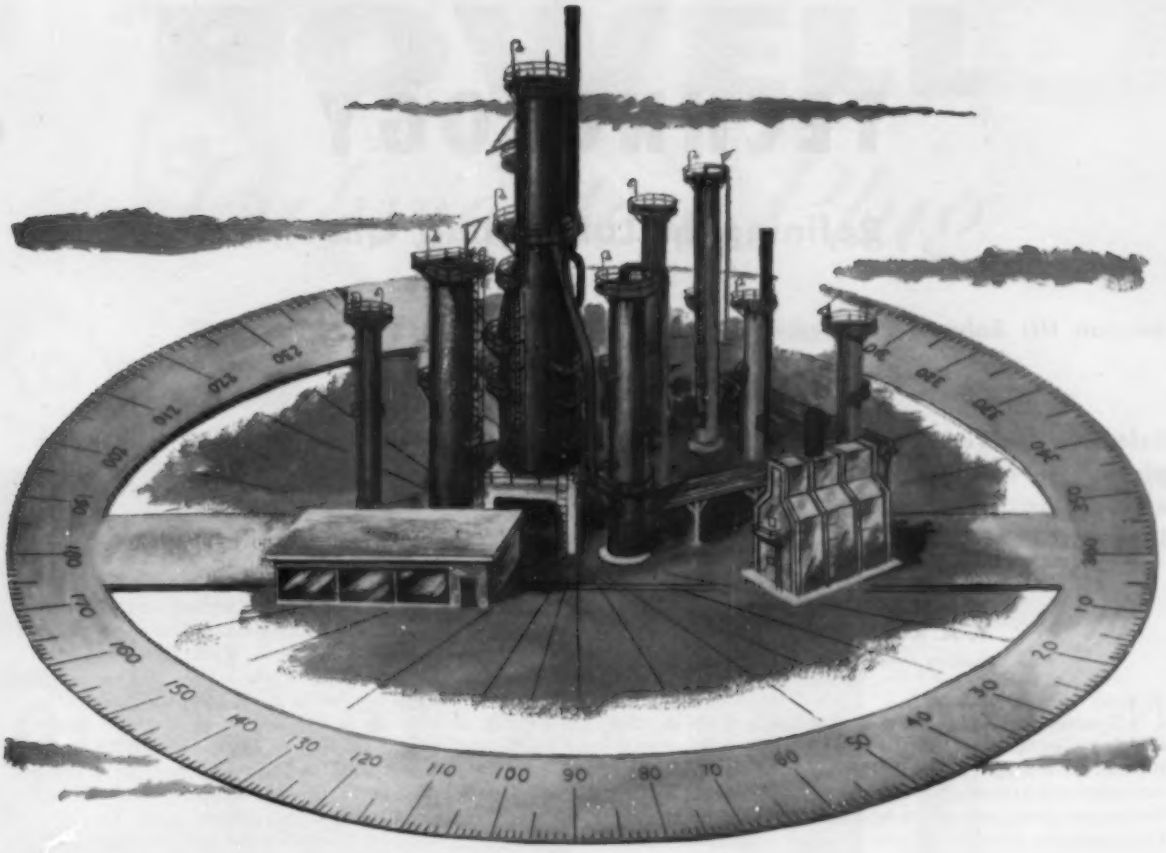

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Section III; Solvent Extraction —

Selective solvent extraction processes, phenol, furfural, nitrobenzene, sulfur dioxide, Duo-Sol, etc., have revolutionized lubricant refining.

V. A. Kalichevsky
Consulting chemical engineer

No solvent was discovered that makes a sharp separation between the low and the high-viscosity index constituents in one stage. The minimum number of stages used commercially is three, but eight and more may be needed for obtaining the best results with some stocks and solvents. Less selective solvents require a larger number of stages than the more selective solvents for obtaining the same extraction effect. As selectivity of a solvent decreases with the extraction temperature, more stages are needed at higher than at lower temperatures for compensating the loss in selectivity. If the quantity of solvent, the extraction temperature and the number of stages are adjusted, the results of extractions are independent of the nature of solvent employed.

Commercial units have a fixed number of stages. When the extraction temperature is raised, the quantity of solvent needed for dissolving a certain percentage of oil is reduced but selectivity of the solvent deteriorates. This loss in selectivity is not apparent over a wide temperature range if the number of stages is large. A temperature is reached eventually when the number of stages is insufficient for compensating the loss in selectivity of the solvent. This is reflected in the reduced yield of the product of the desired quality. The smaller the volume of the solvent required for extracting the oil, the less is the operating expense and the higher the unit throughput if the distillation facilities are adequate. Therefore, small quantities of solvent should be used at the highest-permissible extraction temperature for making the operation most economical.

Addition of a solvent or water to another solvent changes the solvent power and selectivity of the solvent. This is of practical importance. Addition of benzol improves the solvent power of liquid sulfur dioxide without unreasonably lowering its selectivity. This combination of solvents is used in one of the commercial processes. Water is utilized for a similar purpose as described below.

Solvent extraction is a fast process. Solvents dissolve the oil rapidly, and the time and degree of agitation are of little importance if a reasonable degree of mixing is obtained. Under these conditions, the extract and the raffinate layers separate rapidly. Too much agitation may produce fine dispersions and increase the settling time. This does not help the process but reduces the unit throughput.

Solvents used in commercial practice are furfural, phenol, chlorex, nitrobenzene and mixtures of liquid sulfur dioxide and benzol. Conventional extraction units contain from four to eight extraction stages, but modern plants employ counter-flow towers whenever this is practicable. Fresh solvent is introduced at the top and spent solvent is withdrawn at the bottom of the tower. The oil is introduced at the lower portion of the tower and removed at the top. Properties of the solvents used in various commercial processes, including dewaxing and deasphalting, are shown in Table 1.

In the Furfural process, the extraction tower is packed with clay rings. The tower is divided into several sections, each four feet high. Open spaces are left between the sections for redistributing the solvent and the oil in order to reduce channeling. The faster the flow through the tower, the more vigorous the mixing. For maximum efficiency, towers should be operated as closely as possible to their maximum capacity; that is, the rates must be maintained just below those at which the carry-over occurs.

TABLE 1. Properties of refining solvents.

Solvent	Utilization[1]	Chemical formula	Melting point, F	Boiling point, F	Sp. gravity at 68 F	Solubilities at 100 F wt. %	
						Solvent in water	Water in solvent
Acetone	W	CH_3COCH_3	—139	134	0.792	∞	∞
Benzol	W, S	C_6H_6	42	176	0.879	0.16	0.11
Chlorex	S	$CH_2Cl.CH_2.O.CH_2.CH_2Cl$	— 58	352	1.222	1.2	1.1
Cresylic Acid	S						
O-Cresol		$O\text{-}CH_3C_6H_4OH$	86	377	1.047	3.0	14.5
M-Cresol		$m\text{-}CH_3C_6H_4OH$	52	397	1.034	2.5	14.5
P-Cresol		$P\text{-}CH_3C_6H_4OH$	97	397	1.035	2.2	16.5
Ethylene dichloride	W	$C_2H_4Cl_2$	— 32	183	1.257	0.9	—
Furfural	S	C_4H_3OCHO	— 34	323	1.160	9.0	6.5
Methylethyl ketone	W	$CH_3COC_2H_5$	—124	175	0.805	19.0	10.2
Nitrobenzene	S	$C_6H_5NO_2$	42	412	1.199	0.3	0.35
Phenol	S	C_6H_5OH	106	360	1.072	9.4	32.5
Propane	A, W, S	C_3H_8	—310	— 44	0.512	—	—
Sulfur dioxide	S	SO_2	— 99	14	1.434	30	—
Toluol	W	$C_6H_5CH_3$	—139	231	0.866	0.05	—
Trichloroethylene	W	$CHCl:CCl_2$	—123	189	1.456	0.16	0.05

[1] W-dewaxing, A-deasphalting, S-liquid solvent refining.

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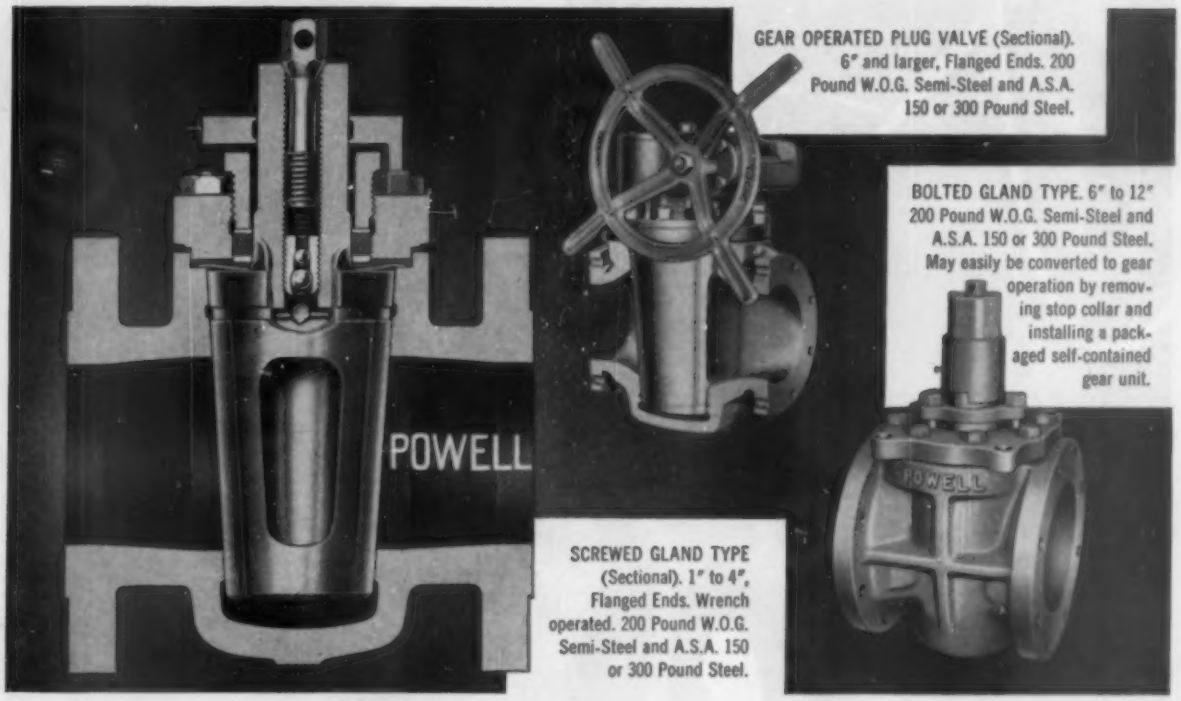

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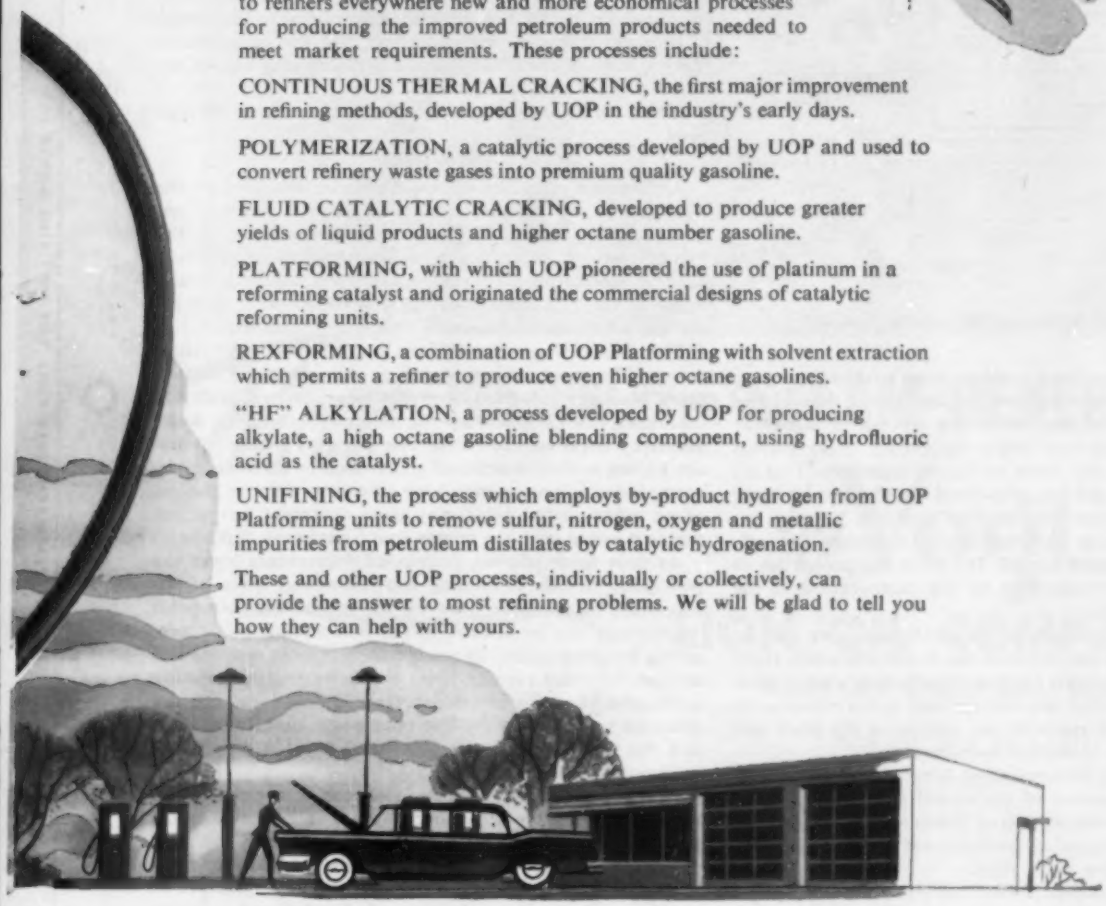

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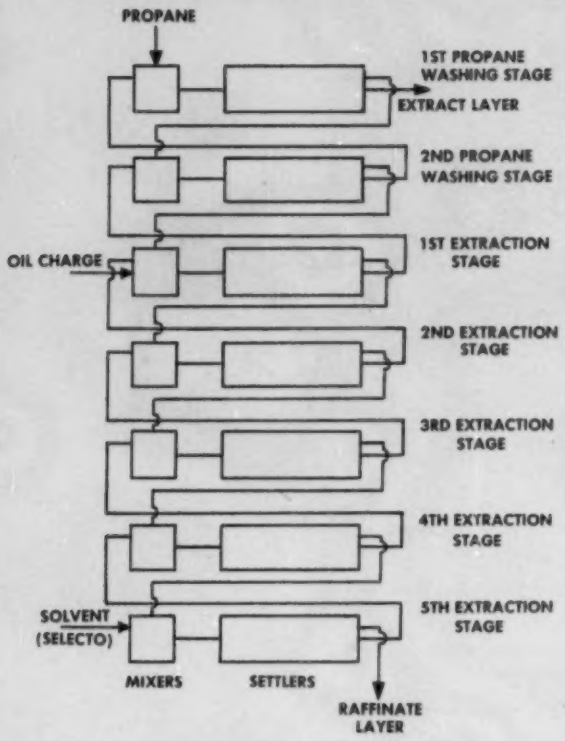

FIG. 8. The Duo-Sol multistage solvent refining process.

A temperature gradient is maintained within the tower by keeping the temperature at the top higher than at the bottom. Solubility of the oil in the solvent is higher at higher temperatures and when the extract layer travels downward it cools and some of the oil separates. This oil rises in the tower and is redissolved by the extract layer gravitating toward the bottom. This produces "internal reflux" which increases turbulence and improves the efficiency of over-designed towers. The yield and properties of the refined oil are controlled by the temperature at the bottom of the tower.

A portion of the extract or of the raffinate layer may be recycled. This may also improve the tower efficiency. However, not many stages are needed for effecting a good separation between the high and low viscosity index constituents and the use of such methods for improving the yield and quality of product is seldom necessary.

Oils refined with furfural often have a dark color. This color is due to presence of suspended particles, probably formed by the decomposition of traces of furfural on distillation. These suspended particles are removed by clay without affecting the filter yield.

In the Phenol process towers are equipped with plates similar to those used in distilling oil. The extract layer flows downward and the raffinate layer, which might be compared to the ascending vapors in a distillation column except that the raffinate phase is liquid, moves upward. Internal reflux is provided by adding a small quantity of water to the extract layer before it leaves the tower. Water reduces solubility of oil in phenol and some of the oil is liberated and recycled within the tower. The function of water in the phenol process is the same as that of the temperature gradient in the furfural process.

Counter-flow towers or stage extractors are used by the rest of the solvent processes. The equipment design is modified depending on the nature of the solvent.

Deasphalting and liquid solvent refining are combined in the Duo-Sol process shown in Fig. 8. This is a countercurrent stage process. The oil is dissolved in propane and contacted with a mixture of phenol and cresylic acid known as Selecto. Propane precipitates asphalt and forces it into the extract layer which contains both asphalt and low viscosity index constituents. Propane is also used for washing out entrained oil from the extract layer leaving the system. This propane is then employed for diluting the oil charge.

Deasphalting, dewaxing and liquid solvent extraction can be integrated. In one of the commercial installations the unrefined residuum is deasphalted with propane. Then the quantity of propane is readjusted and the solution is chilled for removing the wax. The resulting oil-propane solution is finally contacted with Selecto for extracting the low viscosity index constituents.

Lubricating oils can be prepared by dissolving the raw stock in propane and treating the solution with sulfuric acid and caustic or with clay. The oils thus processed are somewhat different from those prepared by treating them in naphtha solution or undiluted. This is due to the action of propane that precipitates asphalt. For the same reason the quantity of chemicals needed for obtaining oils of desired specifications is reduced.

Oils refined with solvents are usually percolated through clay.

Additives

Application of additives was formerly restricted to the light petroleum products but after several years of experimentation additives found an extensive use in the manufacture of lubricating oils. The quantity of additives used in lubricating-oil formulations continues to increase. Some of the oils contain so many additives that they resemble solutions of chemicals.

The lubricating oil additives are divided into many groups. The most important groups are pour-point depressants, viscosity index improvers, oiliness carriers, oxidation inhibitors, anti-corrosion agents, detergents and dyes. Some additives improve more than one property of the oil and are known as multifunctional additives. For instance, a viscosity index improver may lower the pour point of the oil, or an oxidation inhibitor may have detergent properties, that is it would keep the engine free from heavy deposits.

As their name implies, pour-point depressants lower the pour-point of oils containing wax. However, some of the wax must be removed from the oil before the pour-point depressants can be utilized to the best advantage. In preparing low pour-point oils refrigeration is a big expense and its cost increases rapidly when the dewaxing temperature is lowered. If pour-point depressants are used, the oils are dewaxed to a moderately low pour point, usually of 20 F, and the pour-point depressants are added to reduce the pour point to 0 F.

The pour-point depressants lower the pour point of the oil by changing the structure of the wax crystals. In the absence of the depressants the wax separates in the form of interlocking crystals which entrap the oil and prevent it from flowing. Depressants force the wax to crystallize in small particles that remain suspended and do not interfere with the free flow of oil at low temperatures. The presence of wax does not interfere with lubrication and even improves some of the oil properties, such as viscosity index. Santopour, Paraflow and Acryloids are the best known pour-point depressants in commercial use.

Viscosity index improvers are added to the oil to raise the viscosity index. They are viscous liquids that are practically solid at room temperatures. Paratone and acryloid resins are commercial additives of this type. It is of interest that viscosity index of a blend containing heavy and very light petroleum fractions may be higher than the viscosity indexes of the two components.

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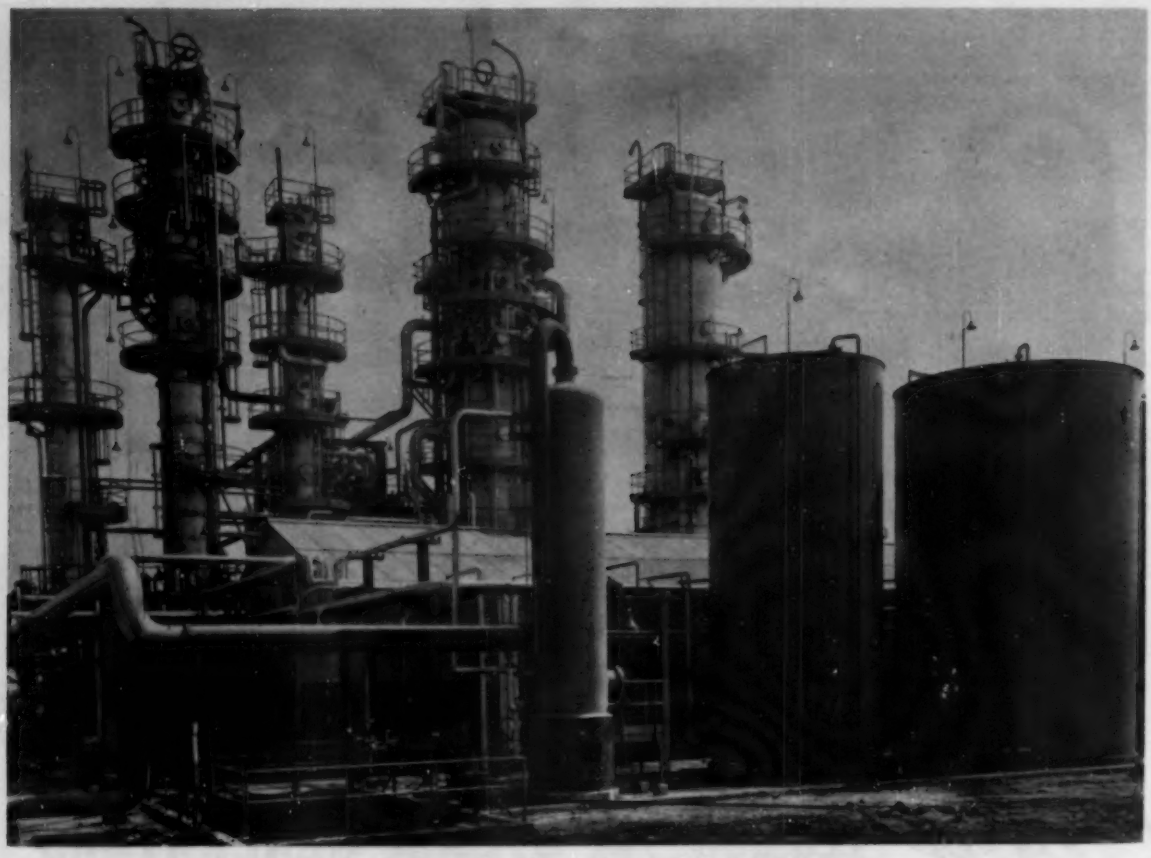

A. An ultra-modern phenol solvent extraction process.

special grades of lubricants. They have no value in lubricating engines having reasonable clearances between the moving parts and operating at low bearing pressures. If clearances are small and the pressures high, the oil may be squeezed from the bearings. This establishes direct metal-to-metal contacts. It results in excessive wear of the engine and raises the bearing temperature. Many chemical compounds that are mildly acidic, like oleic acid, or which contain chlorine, sulfur and similar corrosive agents in their structure, improve the ability of the oil to form a tenacious film clinging to the metal. These additives must be carefully selected in order to avoid engine corrosion. They must stick to the metal without entering into a chemical reaction. The "germ-processed" oils, once widely advertised, are representative of lubricants containing such additives.

If pressure between the rubbing surfaces exceeds certain limits, a condition is reached when the oil film cannot be maintained even with the aid of oiliness carriers. The so-called "high-pressure lubricants" and "anti-welding agents" are then employed. These lubricants contain corrosive compounds that act as metal polishes. Some of them have a chemical action on the metal at high temperatures that develop when the protruding parts of the bearing and the journal hit each other. This chemical action destroys the protruding parts. The nature and quantity of the compounds added to the high pressure lubricants vary widely. It depends on the type of machinery and conditions of service.

Inhibitors retard oxidation of oil by the oxygen of the air. The oxidation products are of two types: Asphalt-like materials forming sludge, and acidic substances that remain dissolved in the oil. Highly refined oils usually form acids, whereas poorly refined oils form sludge. If the oil is properly refined, the quantity of sludge deposited in engines is small but acid formation may be considerable. Acid may attack bearings, particularly if they are made of the new types of alloys developed with primary purpose of sustaining high pressures and permitting high speeds rather than of resisting corrosion. To protect these bearings a special line of corrosion inhibitors has been developed.

Reasons for protective action of the corrosion inhibitors are not clarified. It may be due to chemical reaction between the metal and the inhibitor resulting in formation of a corrosion-resistant film on the metal surface. True oxidation inhibitors should have no effect on the metal. Phosphorous compounds and organic derivatives of certain metals are representative of substances belonging to the class of corrosion inhibitors. They are sold under trade names, such as Santolube and Paranox.

Sludge formed in the engine may settle out or remain suspended in the oil. Certain addition agents, which are said to possess detergent properties, are capable of loosening the sludge and keeping it in suspension. This insures a clean engine and prevents formation of sludge deposits. Suspended sludge is easily removed from the engine when the oil is drained. These addition agents are usually organic compounds of metals. It is possible that in the burning zone of the engine the ash produced by these metal compounds becomes interspersed with carbon making it fluffy and easily removable by the exhaust gases.

Dyes are employed for improving fluorescence of lubricating oils. These dyes must be carefully selected because only a few of them can withstand engine temperatures without decomposition.

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Since Du Pont FOA-2 is an excellent dispersant, it can be used in high temperature operation with excellent results in overcoming filter-plugging and injector-sticking problems. It's economical to use because it is effective in extremely low concentrations.

Ashless

Being nonmetallic and ashless, Du Pont FOA-2 does not contribute to the sparking tendency sometimes noted in connection with the exhaust systems of diesel locomotives.

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EXCLUSIVE

Addition Agents for

Part 2

LUBRICANTS

C. J. Boner

Chief Research Chemist, Battenfeld Grease & Oil Corporation

Lubricating Oil Detergents

The term "detergent" as applied to certain additives used in crankcase and diesel lubricating oils has become accepted, and yet it does not properly describe the function of such compounds. These additives are really dispersants or peptizers for materials that would otherwise appear as deposits on engine parts such as pistons and piston rings (see Fig. 8).

Probably the first detergents added to oils were soluble soaps, such as aluminum or calcium naphthenates. Those now used consist largely of phenates or sulfonates with a lesser amount of polymers. Either the phenates or sulfonates are used as metal salts normally of barium or calcium. While neutral salts are satisfactory dispersants, the tendency is to use basic compounds since they will neutralize any acidic products formed during oil oxidation.

The phenates may be those of alkylated phenols or of alkylated phenol sulfides, such as calcium phenyl stearate or the barium salt of wax-substituted phenol carboxylate sulfide.

Sulfonates may be those derived from petroleum, which may have molecular weights of 300 to 500, such as calcium petroleum sulfonate, or synthetic ones, such as the barium salt of wax-substituted benzene sulfonate. These compounds are available from a number of sources and are sold as solutions (normally 50 per cent) in mineral oil. Such solutions may be priced at from 18 to 22 cents per pound.

Since the general practice is to add both a corrosion inhibitor and a detergent to a lubricating oil, additive suppliers often supply combinations that give desirable proportions. Such proportions may vary with the service to which the oil is subjected. For example, that for an API classification ML, or light-duty oil, will consist largely of oxidation and bearing corrosion inhibitors with little or no detergent. The mixtures for severe service or API classifications MS-DG or even DS will contain a major portion of detergent compounds and about the same proportions of the inhibitors as are found in ML oils.

Further, the oil-base stock may determine proportions or variations in the additives used. The susceptibility of an oil to certain additives can only be determined by actual engine tests. Some large laboratories are prepared to evaluate combinations of lubricating oil additives, and suppliers of detergents and inhibitors either have a background for recommendations or will perform engine tests for customers.

Concentrations of detergents and inhibitors will vary over a wide range. Georgi[7] p. 178 mentions that detergent addition will vary from less than 1 per cent to 20 per cent and that inhibitor addition will vary from ¼ to 3 per cent. The proportions of these materials shown in Table 6 give an idea of the desirable or necessary additions for the two types of compounds.

Some ML oils may contain no additives. As with many other lubricants, cross-grading or multiple-grading occurs with lubricating oils. For example, a distributor may blend an oil to meet the specifications of MS classification. It would then follow that this same lubricant would also serve for both MM and ML classifications. That would

FIG. 8. Pistons from L-4 test, showing result of poor dispersant action on right and good effect on left.
—Monsanto Chemical Company

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Use this chart to order the right packing every time

Service	Brine; Water, Cold	Water, Hot	Oil Distillates	Propane and Butane	Oil Up to 400° F.	Oil Over 400° F.	Ammonia	Caustic	Acid
Centrifugal	193	193	413	16193	193	512	193	Weak 136 Strong 293	293
Reciprocating Steam End	101	101	101	101	101	101	101	101	101
Fluid End	16010	16010	16012 151	16012 151 16133	16022 251	16022 512	133	16022 251	293
On Piston	463	453	575	575	...	...	...	...	...
Valve Stem	125	125	413	16193 16133	125	512	125	125	293
Gaskets	9	9	899	899	899	899	9	9	19069 899

Gaskets for: Boilers—Handhole and Manhole 812
Sweetland Press 8797
Tank Car Gaskets { Bolted Type ..... 1771 / Screw Type 4773

First style number listed for each condition is best recommendation for that particular service.

No longer do you have to wade through the confusion of selecting from hundreds of different packings. The packing recommendations on this chart will pack just about every condition in your refinery.

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PACKINGS

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STYLE 193—U. S. CENTRIFUGAL PUMP PACKING

For centrifugal pumps, or other rotating or oscillating rods or shafts, handling hot or cold, fresh or salt water, oil, brine, weak acids, caustic solutions and ammonia. Made of long fibre asbestos yarn, plaited square. Each strand thoroughly lubricated and graphited.

STYLE 101—U. S. RAINBESTOS HIGH-PRESSURE ROD AND PLUNGER PACKING

Designed for high-pressure steam, air and gas up to 500° F. Made from selected asbestos cloth, woven from tightly twisted asbestos yarn, with a genuine U. S. Rainbow non-hardening cushion, formed square, and treated with heat-resisting lubricants and preservatives and with a graphite solution.

STYLE 101

STYLE 16010—DUCK AND RUBBER

STYLE 16010—U. S. MATCHLESS PACKING

Matchless is the high-pressure packing—will withstand hydraulic pressures as high as 8000 pounds. Self-adjusting, automatic action results in reduced wear and tear on rods and plungers, minimizes friction, keeps down packing costs. For hydraulic equipment, presses, rams, triplex pumps, outside packed pumps, and swivels on rotary drilling rigs.

STYLE 463—U. S. PEERLESS CANVAS PUMP PACKING

For service on inside packed pumps against hot or cold water, and for end rings in hydraulic sets. Made from first quality, closely woven duck laminations cemented together with a high quality rubber friction. Light in weight.

STYLE 463

STYLE 125

STYLE 125—U. S. WIZARD ROUND BRAIDED ASBESTOS PACKING

For use in valve stems, reciprocating rods and plungers, against steam, air, hot and cold water, ammonia, oil, chemicals and some acids. Made of long fibre asbestos yarn, braided in round cross-section in the braid-over-braid construction, thoroughly lubricated and graphited throughout.

STYLE 899 (F.O.P.)—U. S. COMPRESSED ASBESTOS SHEET

F.O.P. (Fibre Oil-Proof) is the original oil-proof asbestos fibre high-pressure sheet developed especially for oil industry conditions. Recommended for packing flanges or joints against superheated or saturated steam, air, ammonia, gases, oil, gasoline, water, some acids, alkaline solutions and other chemicals. Ideal for Still Head gaskets. It will not soften, burn, blow or ooze out of a joint, and does not deteriorate with age in stock.

STYLE 899 (F.O.P.)

Mechanical Goods Division

United States Rubber

permit of fewer grades of oil being carried in stock and also perhaps it insures a customer, asking for an oil for light duty, of a better lubricant than would ordinarily be supplied.

One compound may serve a dual purpose, and in this case it will be used in increasing amounts as the oils compounded vary from low-duty to severe — or heavy — duty service. For example, calcium salts of the capryl or octyl ester of salicylic acid are claimed to have both an antioxidation and anticorrosion effect as well as that of a detergent. Some detergent-dispersant-inhibitor type additives, such as "Santolube 360, 374, and 379," are also stated to be effective pour-point depressants.

Detergents are thought to function either by chemical or physical means to retard the formation of engine deposits. One chemical theory considers that detergents that are basic, such as metal sulfonates, combine with oxyacids that have been formed in the hot oil. This sets free the weaker sulfonic acids that are capable of forming lacquer, whereas the free oxyacids might do so. The physical action may consist of adsorption of the additive on not only the metal surfaces, where it will prevent varnish formation, but also on particles of oil-insolubles, thus keeping these in suspension in the oil. In any event, reference to Fig. 8, 9 and 10 indicates the value of detergent addition.

The chemical compounds effective as dispersants may not remain the same chemically when they have been in service for even a short period, and their final form may not be the same in different types of oils. This then is one reason why such additives have to be evaluated by engine tests in the specific oil in which they are to be used.

Additives in crankcase and diesel oils are probably used up to a greater extent during service than are most additives employed in lubricants. Therefore, the question is raised as to when either the additive is depleted or the oil is deteriorated to the point requiring draining. With the larger dosages of additives, the oil may still be satisfactory at the usual drain periods, say 2000 miles service. Attempts have been made to evaluate this point by spot tests using filter paper. Any such test to be successful should have a standard of a known contamination and deterioration with which the oil in the crank case can be compared. Another method of evaluation depends upon a pH determination with a value of perhaps 5.5 or at the most 6 being the maximum before a change should be made in the oil in the engine. This figure may vary with the particular additives employed.

The actions mentioned above have been based on the consideration that the treated oil was added to a clean engine. If added to an engine that has deposits from previous use, most detergents will loosen part of the old deposits. In some cases the particles of lacquer will be so large that they will not be finely dispersed and, as a consequence, may even stop up oil lines. Even then, all of the old deposits may not be removed by the detergent oil.

As might be expected, a lubricating oil containing a detergent when drained from an engine should look dirty indicating that solids had been removed and not retained in the engine.

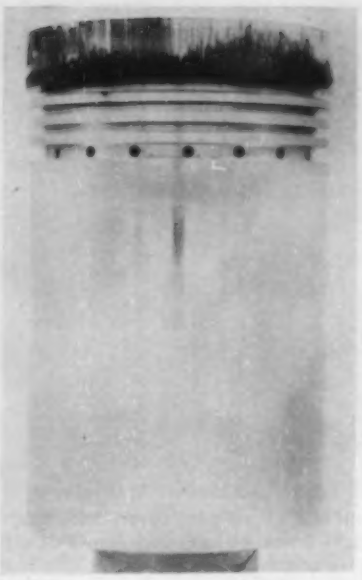

FIG. 9. Piston from Caterpillar L-1 test-pass criterion-carbon and lacquer filling of ring grooves.
—Monsanto Chemical Company

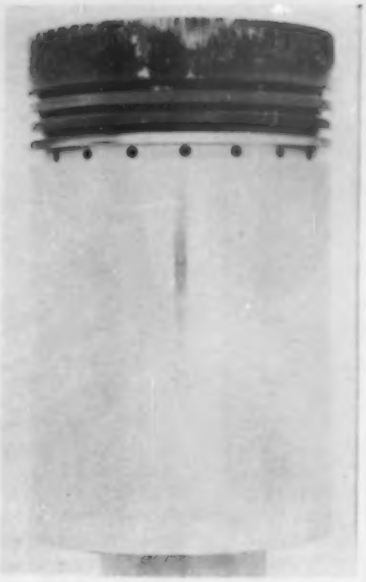

FIG. 10. Piston from Caterpillar L-1 test-fail.
—Monsanto Chemical Company

Speculation as to whether the detergent is removed from oils by filters has been followed by tests which indicate that in general, earth-type filters will remove detergents but that other filters, such as paper, will not remove any appreciable amount unless the oil is quite dirty.

Detergent-inhibitor type additives for motor oils are marketed as fluids with characteristics similar to the following:

Color, ASTM diluted	3 to 5
Viscosity, SUS at 210 F	45 to 75
Specific Gravity at 60/60 F	0.90 to 1.05
Ash per cent	4.0 to 7.0

In addition to the above characteristics, the percentage of certain active ingredients, such as barium, calcium, phosphorus, sulfur, and zinc, may be given.

Detergent-inhibitor type additives are quoted on a gallon basis and may range from $1.40 to $2.75 per gallon. The oxidation and corrosion inhibitors are generally more expensive than the detergents, and, hence, mixtures high in proportion of the latter will be the least expensive.

TABLE 6. Proportion of detergents and inhibitors in lubricating oils.

API classification	Test criterion	Oxidation and corrosion inhibitor per cent	Detergent per cent
ML	L-4 Engine	0.5 to 0.7	0 to 0.5
MM	L-4 Engine	0.5 to 1.0	0.5 to 1.5
MS	L-4 or L-1 Engine (fuel 0.35% S)	0.5 to 1.0	3.0 to 4.5
DG Sup. I	L-4 or L-1 Engine (fuel 1.0% S)	0.5 to 1.0	5.5 to 8.0
DS Series II	L-4 Engine	0.5 to 1.0	12.0 to 15
DS Series III	L-4 Engine	0.5 to 1.0	18.0 to 25

Engine Tests for Evaluating Inhibited-Detergent Type Oils

The engine tests normally used for the above types of oils are described in detail by Georgi[7] p. 66-92 and hence will only have slight mention here.

The L-1 Engine Test is so called because C.R.C. designated this as L-1-

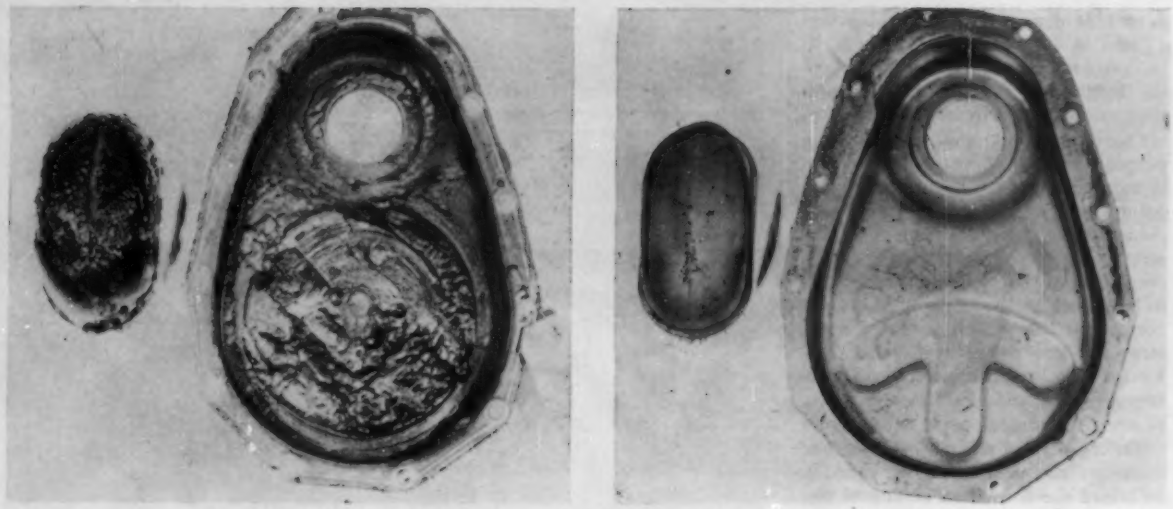

FIG. 11. Screens and timing gear covers from field test stop and go driving. First with no low temperature detergent and next with such an additive.

—The Standard Oil Company (Ohio)

545. A description of the test is also given as U. S. Army Tentative Specifications AXS 1515. The engine used is a single-cylinder, Caterpiller diesel test engine. The test, which is run for 480 hr, is widely used for evaluating detergency characteristics of heavy-duty type oils. Experience has also shown that this procedure correctly evaluates oils for automobile engines.

The L-4 Engine Test has C.R.C. designation L-4-545 and U. S. Army Ordnance Specification AXS 1554. This test is intended for determining the oxidation and bearing corrosion characteristic of engine crankcase oils for use under heavy-duty service. The period of test in this case is 36 hr.

Results of some such tests are shown in Fig. 8, 9 and 10.

Low-Temperature Detergents

The detergent additives previously discussed have been employed primarily to prevent deposits that are due to high-temperature operations of internal combustion or diesel engines. Where what is known as stop-and-go, or rather city driving, with frequent stops prevails, particularly in winter, a different type of deposits is formed. Such deposits may not become hard lacquers but instead are sludges that may gather on mechanisms, stop up screens, and even make the oil too heavy to circulate properly or to drain. Some such deposits are shown in Fig. 11, and 12, where the use of additives indicates their value.

Certain polymers have been found effective as dispersants under the above conditions. One such, distributed by DuPont as "LOA 564 or 565," consists of lauryl methacrylate diethyl amino ethyl methacrylate copolymer. The difference shown in the two types is in the viscosity, which in turn is no doubt due to a difference in molecular weights of the polymers. About 2.5 per cent of the above is said to be sufficient. In addition to the detergency, this type of additive increases the viscosity and V.I. of the oil. Being ashless, these polymers do not contribute to combustion chamber deposits and preignition tendencies.

Another polymer offered as a low-temperature detergent is "Acryloid 966," a product of Rohm and Haas that is said to function as a combined V.I. improver—pour point depressant —and low-temperature sludge dispersant. This additive is said to have no effect on oil oxidation or bearing corrosion. It is used in proportions by volume of 2.8 to 6.7 per cent.

While high-temperature detergents may be included in oils that also contain the low-temperature detergents, some of the effectiveness of the former is lost due to the action of the polymers. Some combinations of the two additives are more compatible than others, but consideration should be given to the effect of the one type on the other. Further, water accumulates during low-temperature operation of engines, and this water may rob the oil of its high-temperature detergents.

(Bibliography will appear in Part 3.)

End Part 2

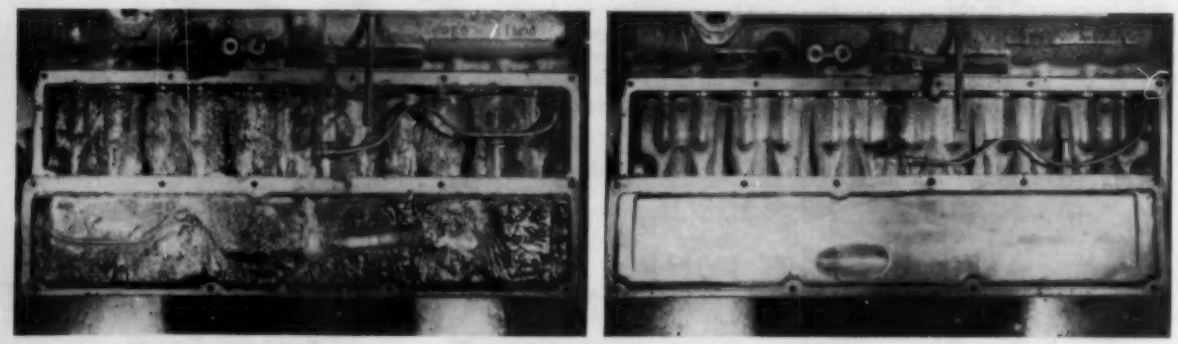

FIG. 12. Side pans from field test-stop and go driving. First with no low temperature detergent, next with such an additive.

—The Standard Oil Company (Ohio)

Gas Dehydration

Q In the design of gas dehydration units, how are the calculations made, and how are the various sizes, quantities of dehydrating agent, etc., determined for a given amount of gas, assuming for calculations definite values for the various factors needed in making the calculations? Please give the different results and computation routines for different dehydrating agents; sizes of equipment and how calculated; sizes of regenerating equipment, capacities, power, heater capacity required and how calculated, etc.

M. C. N.

A The basic design of a dry desiccant dehydrator involves the following major calculations:

1. Calculation of desiccant requirements
2. Determination of the adsorber vessel's length and diameter
3. Sizing the regeneration system heat source.
4. Sizing the regeneration gas cooler
5. Determination of the proper flow sequence in the unit

Before tackling these problems, however, it is necessary to determine the general requirements of the dehydration project, such as dew-point depression required, utilities available, practical operating problems, choice of desiccant, etc. Because of the wide variation in these conditions, it is not surprising that a number of slightly different designs are found throughout the field. In general though, most systems consist of two towers that switch on 8-hr cycles, with natural gas being used as the regenerating medium. Regeneration is normally obtained by heating a portion of the wet inlet gas that is bypassed around the dehydrator, this gas being subsequently cooled by the cool, dried exit wellstream, with air coolers or using water. Fig. 1 is typical of such a system.

Desiccant

The choice of desiccant is largely contingent upon the operating requirements and personal preference. There are a number of excellent ones available that may be roughly subdivided as:

Type	*Common Trade Names*
Bauxite	Florite, Dri-O-Cel, Porocel, etc.
Purified Bauxite	Activated Alumina
Silica Gel	Sovabead, Silica Gel
Alumina Gel	H-151

The gel-type desiccants have a higher sorptive capacity for water but are correspondingly more expensive. The gel type costs from 20 to 35 cents per pound and the bauxite 5 to 12 cents per pound depending on the quantity and type. The properties of each and representative test data have been published in the literature (1-10).

It is extremely difficult, if not impossible, to establish general comparative economics on desiccants because of the wide variation in service requirements and desiccant life in the various applications.

For design purposes, the following sorptive capacities are often used when dehydrating high-pressure natural gas:

Type	*Pound Water per 100-lb Desiccant*
Activated Bauxite	3 to 6
Activated Alumina	3 to 6
Gel Type	5 to 7½

The choice of sorptive capacity is one of the basic decisions necessary before starting the design.

Desiccant Requirements and Tower Sizing

The water content chart shown in Fig. 2 (11, 12) is the one most commonly used through the gas industry although many companies prefer others. In order to illustrate its use, consider the following dehydration example problem:

Gas flow rate: 10 MMcfd @ 14.7 psi and 60 F.

Inlet pressure: 1000 psi.

Inlet Dew Point: 90 F.

Required Outlet Dew Point: 10 F.

Desiccant sorption capacity: 5 per cent.

Cycle Length: 8 hr.

Regeneration: Natural gas.

Cooling: Dry natural gas.

Type of Towers: Vertical.

Allowable Gas Velocity: 30 ft-min.

Actual inlet gas temperature: 95 F.

Specific Gravity of Gas: 0.70.

From Fig. 2, the inlet water content is 46 lb/MMcf, and the outlet is 2.9 lb/MMcf, making a total of

(10) ((46 — 2.9) = 431 lb of water adsorbed/24 hr.*

*Note: It is sometimes assumed that all the water will be removed to introduce some safety factor since no effective control is often possible over the outlet dew point.

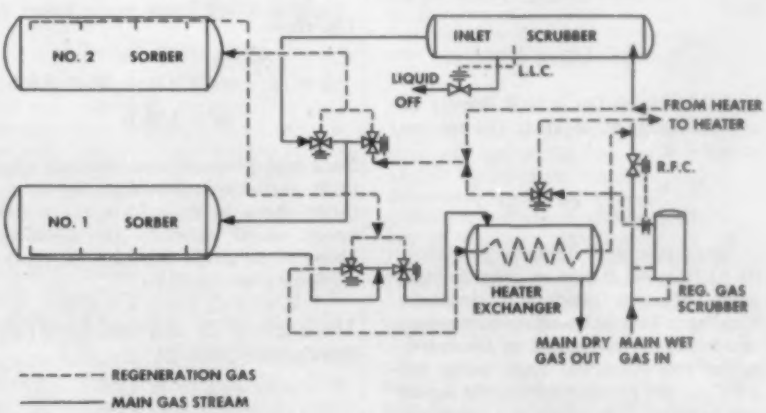

FIG. 1. System for desiccant regeneration, employing a by-passed heated gas stream from the main wellstream.

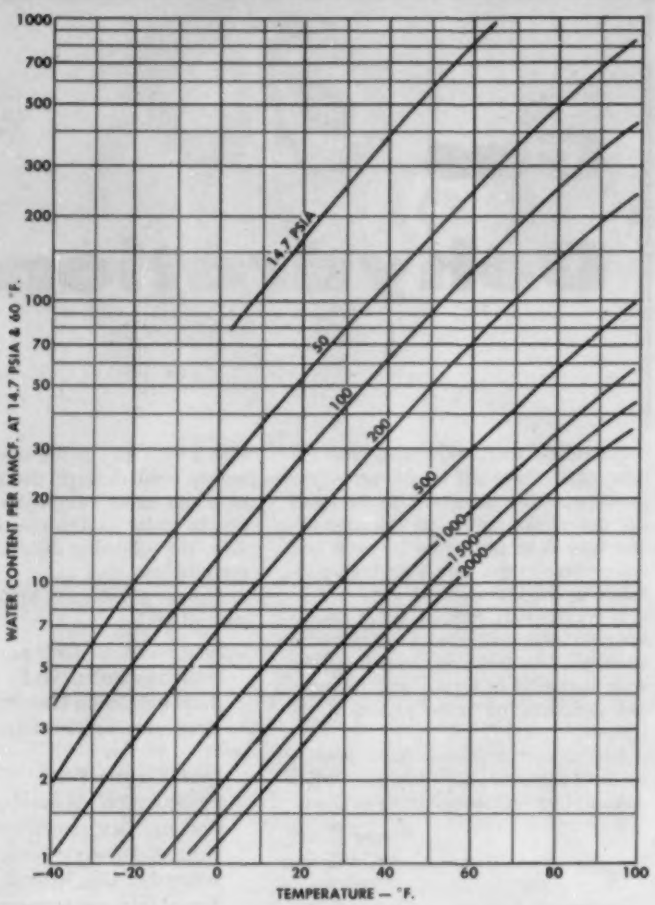

FIG. 2. Water content chart for wet gases, one of the charts commonly used by the industry.

On an 8-hr cycle, each sorber must adsorb

$$\frac{431}{3} = 143.7 \text{ lb of water.}$$

At 5 per cent sorption, each tower must hold

$$\frac{143.7}{0.05} = 2874 \text{ lb of desiccant.}$$

If the desiccant has a bulk density of approximately 50 lb/cu ft, the volume required is:

$$\frac{2874}{50} = 57.5 \text{ cu ft.}$$

Many operators limit the gas velocity to 30 to 45 ft/min in order to minimize pressure drop and desiccant breakage. This is based on experience and is usually calculated on the empty tower cross-sectional area, using the ideal gas law for determining the actual gas velocity. The result is a quasi-velocity figure for use with the above "rule of thumb."

Gas flow rate =

$$\frac{(10{,}000{,}000)\ (14.7)\ (540)}{(24)\ (60)\ (800)\ (520)} =$$

132 cu ft/min @ 800 psi.

Cross sectional area = $.785D^2 = A$

Therefore:

$$A = \frac{132}{30} = .785D^2 \qquad D^2 = 5.61$$

$$D = 2.38 \text{ ft.}$$

Since high-pressure heads are only normally available in 6-in. diameter increments above 24 in., a 30-in. ID or OD vessel would normally be specified. Using 30-in. inside diameter, the cross-sectional area would be

$$(.785)\ (2.5)^2 = 4.9 \text{ sq ft.}$$

The length of the desiccant section required would then be

$$\frac{57.5}{4.9} = 11.7 \text{ ft.}$$

The total vessel length would then depend on the mechanical design used by the individual manufacturer.

The desiccant length found above gives a pseudo gas-desiccant contact time of

$$\frac{11.7}{30} = 0.39 \text{ min} = 23.4 \text{ sec.}$$

This is satisfactory. At least several seconds contact time is desired in order to allow for the rate of adsorption of water by the desiccant. In any event, it is recommended that the desiccant bed should be not less than 2 to 3 ft thick to prevent channeling. In a few instances, this requirement may cause the use of more desiccant than is indicated by calculation from the water content of the gas.

The towers may be either horizontal or vertical, each differing with the manufacturer. Consequently, the internal design may be expected to differ. Since many of these designs give satisfactory service, the choice usually depends on personal preference and/or price. Regardless of design, the gas velocity and desiccant requirements should generally satisfy the above recommendations.

Several more rigorous methods other than that outlined above are available but do not give any greater effective accuracy.

Regeneration Gas Requirements

The quantity of gas needed for regeneration will obviously depend on the amount of heat needed to heat up the desiccant bed and the specific heat of the gas used. Fig. 3 shows the typical temperature distribution in two-tower system using natural gas.

The final bed temperature needed for regeneration will vary with the pressure, the service, and to some degree with the desiccant used. An outlet temperature of 325 to 350 F (Curve 2) is generally satisfactory, however. By the same token, the inlet regeneration temperature (gas from the heater) is normally about 400 F.

The total heat load may be subdivided as follows:

1. Heat of de-sorption of water
2. Latent heat of vaporizing water
3. Sensible heat of heating water to the vaporizing temperature
4. Sensible heat of heating desiccant
5. Sensible heat of heating up the tower shell
6. Heat losses

Items 1 and 2 may be combined by using the latent heat of water times 1.1 since data on Heat of Desorption are not complete. The following sensible heats will give good results:

DU PONT

PETROLEUM CHEMICALS DIVISION NEWS

DU PONT

May ★ One of a Series of Bulletins for the Petroleum Industry ★ 1956

ONE COMPLETE LINE

Only Du Pont offers you a *complete* line of additives . . . for gasoline, for diesel and heating fuels, and for lubricating oils. Du Pont also offers grease stabilizers and dyes. To bring yourself up to date on the benefits of these products, read about them below and on the next page.

1. AN ASHLESS heating and diesel fuel oil additive. (See below.)
2. A NEW TYPE of lube oil additive that fills the growing need for low-duty detergency. (See below at right.)
3. COPPER CONTAMINATION in a wide variety of petroleum products can be controlled. (See article on Du Pont Metal Deactivator on next page.)
4. COLOR is adding new sales advantages to many petroleum products. (See next page.)
5. GREATER ECONOMY can result from purchasing Du Pont additives in carload lots. (Read about it on the next page.)
6. MULTI-PURPOSE greases for high temperature service require additional stability. (The Du Pont grease stabilizers written up on the next page can help you achieve it.)

ASHLESS additive to help you avoid oil burner and diesel troubles

Since it is a nonmetallic ashless additive, Du Pont Fuel Oil Additive No. 2 (FOA-2) does not leave a metallic ash deposit that can foul the operation of oil burner electrodes and stack controls. Also, it can be used in diesel fuels without any danger of contributing to exhaust sparking.

Many other advantages

Added to freshly prepared heating oil stocks at the refinery, FOA-2 retards the formation of insoluble residues in storage and customer tanks. It also reduces the particle size of any residues that are formed and helps to clean out any sludge deposits that might previously have formed in oil burner systems.

In diesel fuels, its stabilizing and dispersant action can help prevent injector sticking and filter plugging. In this way, FOA-2 provides a means of making economy grade, cat-cracked fuels highly acceptable for diesel operation.

New setup to expand customer service to refiners on Du Pont additives

The continuing upsurge in both volume and quality of petroleum products has increased the demand for all types of chemical additives. To meet this growing demand, the Du Pont Petroleum Chemicals Division has recently followed the lead established for TEL and streamlined its sales and technical service setup for the handling of all Du Pont additives.

J. J. MIKITA, right, Sales Manager, additives, and RICHARD O. BENDER, an Assistant Director of the Petroleum Laboratory, head up the new Petroleum Chemicals Division additives sales and technical service groups respectively.

•

A group under Mr. J. J. Mikita will have charge of the sale of Du Pont Metal Deactivator, gasoline antioxidants and dyes, fuel oil and lube oil additives, and grease stabilizers. In his former capacity as director of the Du Pont Petroleum Laboratory, Mr. Mikita had unusually broad experience in the development and application of all types of petroleum additives.

Mr. R. O. Bender, who has also been closely associated with the development of many Du Pont additives, will now be headquartered at the Du Pont Petroleum Laboratory. There, as an assistant director of the Laboratory,

To meet your need for low-duty lube oil detergents

Du Pont Lube Oil Additives 564 and 565 were especially developed to give effective detergency to motor oils for low-duty, around-town driving conditions. In addition to their detergency action, they will also add a substantial amount of your desired viscosity-index improvement.

Since a large part of the average motorist's driving is in stop-and-go city traffic, these unique additives offer you a strong promotional appeal for your motor oils.

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OVER

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NEWS

DU PONT

CONTINUED **New Service Setup**

he will be able to closely coordinate the Laboratory's work with technical service for customers.

The new setup will provide thoroughly experienced personnel ready at all times to help refiners on both technical and commercial problems concerning the use of additives.

Together, these groups will devote their entire energies toward helping refiners make the most efficient use of Du Pont's complete line of additives for gasoline, diesel fuel, heating oil, lube oil, grease and other products.

Du Pont Metal Deactivator has wide range of valuable applications

In addition to gasolines, the list of products that can be improved with Du Pont Metal Deactivator (DMD) includes diesel fuels, home heating oils, kerosines, jet fuels, turbine oils, and greases.

Wherever copper contact is a possibility, there is danger of contamination and gum formation. But in most cases, a very small amount of DMD will supply adequate protection against the harmful effects of copper.

To help you take advantage of the benefits of Metal Deactivator in many different products, Du Pont offers comprehensive technical services. And these services are geared to your own individual needs and manufacturing operations.

Convenient laboratory help

The facilities and experience of the five Du Pont regional laboratories are an important part of these services. The laboratories may be able to help you put your whole additives program on a more economical basis.

For example—because combinations of DMD and other Du Pont additives often work more efficiently than one additive alone, the Du Pont laboratory recommendations can help you achieve your desired stability with less additive . . . often at a substantially lower treating cost.

Color helps you sell, identify, add interest to MANY petroleum products

Color is becoming a bigger factor in our everyday lives . . . and in the competitive struggle for sales. You see it in the cars on the street, in home decorating, in sport shirts at the beach.

It's important in petroleum products, too. Leaded gasolines have always been dyed. And many refiners have used gasoline dyes to match their pumps, station trim and brand identification signs. Many use it for sales promotion purposes in their motor oils, also.

TO GET the best results with Du Pont additives, you are always welcome to use the services of our conveniently-located regional laboratories.

Now greases and fuel oils are becoming more colorful. And the advantages of this go beyond the promotional value. Colored greases help service station personnel and industrial lubrication engineers identify the products and check their work. Fuel oils and other products can be readily identified by grade during pipeline shipments and at other points by the simple addition of color.

For adding these advantages to *all* your products, Du Pont offers a complete line of oil-soluble dyes—yellow, orange, red, blue and bronze. Their color stability is outstanding. And they are highly concentrated for economical use.

Grease stabilizers to meet varying requirements

As operating speeds and temperatures are pushed higher, grease stability is of increasing importance.

Du Pont "Ortholeum" 300 is highly effective as a metal deactivator, as well as an antioxidant. This quality is especially important in heavy-duty industrial greases which come in contact with bearings containing brass. It also provides unusually good resistance to color deterioration.

Du Pont phenyl-alpha-naphthylamine gives excellent results in most non-catalyzed systems. Where operating conditions are not too severe and competitive pricing is important, it can be used to increase stability at relatively low cost.

To help you save on cost of additives . . .

Du Pont additives are available in carload lots.

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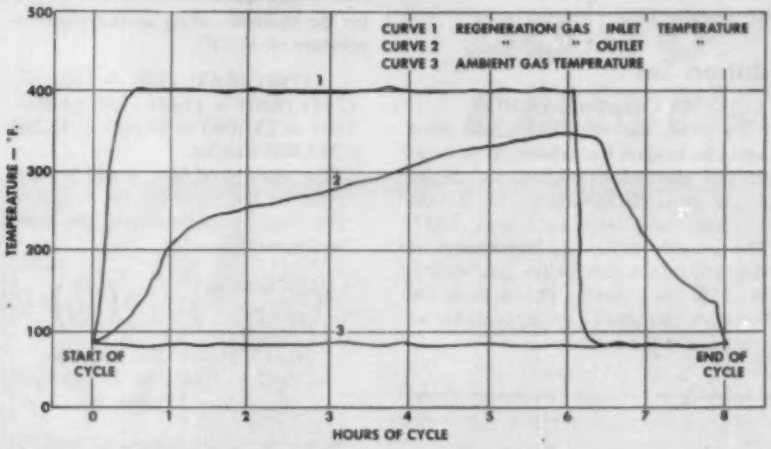

FIG. 3. Typical curves showing temperature distribution in a two-tower system using natural gas for regeneration of desiccant.

Material	*Specific Heat-Btu/lb-F*
Any desiccant	0.25
Steel	0.11
Gas	References 13 and 14
Water	1.0

Enthalpy charts, when available, are excellent. There are many ways of calculating the specific heat and/or enthalpy changes for gas, but the references shown are easy to use and give satisfactory results. In the absence of charts, the assumption of 0.64 Btu/lb-F as the specific heat of natural gas will usually be satisfactory at pressures less than 1000 psi.

One method of calculation would be to determine the total heat load and then divide by the cycle length to obtain the heat load per hour. This would be incorrect, however, for, by examination of Fig. 3, it may be seen that the heat load will vary for each hourly period. It is, therefore, necessary to supply sufficient regeneration gas and size the heater for the maximum load during any period.

Some manufacturers solve this problem of varying heat load by empirical means. Experience and field data have shown that at least two-thirds of the water are vaporized during the 1-hr period following the time when the bed temperature reaches 250 F. Since the vaporization of water is usually the major source of the variable heat load, it is recommended that the heat load in Btu/hr be obtained for this hour period, assuming that all the water is evaporated.

For the example, the following data may be found:

Tower wall thickness: 0.925 in. (Using ASTM A212 Gr. B. Firebox grade steel.)

Estimated Vessel Weight: 5500 lb.

Specific heat of 0.70 sp-gr natural gas @ 1000 psi and 325 F—0.64 (14).

Temperature at beginning of hour period (Fig. 3)—250 F.

Temperature at end of hour period —275 F.

Average temperature during hour period—263 F.

Pounds of water adsorbed (8-hr cycle) — 144 lb.

Latent heat of water at 1000 psi—650 Btu/lb.

The following balance may, therefore, be made, neglecting the heat load for any hydrocarbon adsorbed on the desiccant:

$$q_s = (M)(S)(\Delta t)$$
$$q_L = M\Delta H_D$$

where

q_s = sensible heat load—Btu/hr.
q_L = latent heat load—Btu/hr.
M = lb/hr.
Δt = temperature rise (275 — 250 = 25 F).
ΔH_D = 1.1 latent heat of vaporization of water at tower pressure.

Heat of Desorption
(144) (1.1) (650) = 103,000 Btu/hr.

Water Sensible Heat
(144) (1.0) (275 — 250) = 3600 Btu/hr.

Heating Desiccant Bed
(2874) (.24) (275 — 250) = 17,200 Btu/hr.

Heating Vessel Shell
(5500) (.11) (275 — 250) = 15,100 Btu/hr.

Total heat load = 139,000 Btu/hr. Adding 10 per cent for line and vessel —heat losses gives a total heat load of 153,000 Btu/hr.

The quantity of regeneration gas required during this 1-hr period may be determined from the fact that the gas entering at 400 F gives up an average heat equivalent to its cooling to 263 F.

Let X = pounds of regeneration gas required per hour

$$153{,}000 = (X)(.64)(400 - 263)$$
$$X = 1750 \text{ lb/hr.}$$

This is equivalent to

$$(1750)(24)\left(\frac{379}{(0.7)(29)}\right)$$

= 787,000 scf/day @ 14.7 psi and 60 F. Therefore, the regeneration gas represents $\frac{0.787}{10}(100) = 7.87$ per cent of the total wellstream flow rate. In general, this percentage will be between 6 and 16 per cent.

The heater must heat this regeneration gas from the ambient line temperature to the regeneration-gas inlet temperature. Consequently, the heater rating would be found as follows:

$$\frac{(1750)(.64)(400 - 95)(1.25)}{0.70}$$

= 610,000 Btu/hr.

The 0.70 represents the usual firebox efficiency of a well designed heater and the factor 1.25 serves as a safety factor to account for variations in the design conditions that affect the heat load. Experience has shown this factor to be very cheap insurance indeed.

Upon leaving the tower, the hot, wet regeneration gas must be cooled to condense the water picked up and to cool the gas proper so that it may be returned to the main gas line. It is, therefore, necessary to calculate the heat load around the exchanger used.

In the absence of utilities, the main gas stream is often used for this purpose. Using countercurrent flow, the use of a 15 F approach to the main gas stream temperature of 95 F results in an economical exchanger. Consequently, the regeneration gas would leave the exchanger at, or near, 110 F. Actually, the regeneration gas at 110 F being added to the main gas stream at 95 F increases the temperature of the wellstream slightly, which, in turn, raises the temperature of the gas from the exchanger, etc. This cycle process, of course, reaches equilibrium and would require a series of successive calculations before a final heat balance were obtained. It is satisfactory, however, to use only the initial conditions since the effect of this cyclic change on the sensible heat portion of the balance is small, the latent heat, of course, remaining constant.

For purposes of the balance, it is simpler to assume that the water vapor is condensed at the temperature at which the hot gas leaves the tower. Even though this does not actually take place, it will yield a correct answer since the enthalpy change is a complete differential thermo-dynamically. The following balance may then be written

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The ACHEMA 1958, twelfth Chemical Apparatus and Equipment Congress and Exhibition, will be held in Frankfurt am Main during the period May 31-June 8, 1958. These dates have been fixed by the board of management of the DECHEMA, Deutshce Gesellschaft für chemisches Apparatewesen, Frankfurt am Main, which has been responsible for all arrangements in connection with the ACHEMA Congress since 1920.

In 1958, the ACHEMA will once again be held on the exhibition grounds of the city of Frankfurt am Main, where all ACHEMA congresses and exhibitions have been held since 1937. The steadily increasing importance of the ACHMEA congresses and exhibitions is very closely linked with the constant increase in the importance of chemical engineering.

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for the example, using an exit-gas temperature of 340 F:

$$(1750)\,(0.64)\,(340-110)+(144)\,(650)+(144)\,(1.0)\,(340-110)=257{,}000+93{,}600+33{,}200=383{,}800 \text{ Btu/hr.}$$

This amount of heat would be supplied by the main stream. Let X = the final temperature of the main wellstream

$$\left(\frac{10 \text{ MMcfd}}{24}\right)(0.70)\left(\frac{29}{379}\right)$$

$$(0.64)\,(X-95)=383{,}800$$

$$14{,}300X-1{,}360{,}000=383{,}800$$

$$X=122 \text{ F.}$$

Many gas sales contracts limit the dehydrator outlet temperature to 110 to 120 F. Consequently, if the temperature calculated as above exceeds such limitations, consideration must be given to other cooling methods. The use of the main gas stream for cooling also has the disadvantage of introducing more pressure drop into the system.

If electricity is present, in the absence of water, air cooling might be used for precooling the hot gas, the main wellstream being used only for the final cooling, if the ambient air temperature is too high. Water cooling is usually recommended if it is present in sufficient quantity.

It is suggested that calculation of the surface needed for cooling the regeneration gas be referred to the manufacturer since the heat-transfer coefficient varies with the design.

Experience has shown that use of the above calculation methods yields sufficient and accurate information for determining the basic needs of a dry desiccant dehydrator. The detailed design of the individual components must necessarily be handled by one experienced with the practical factors affecting said design.

Dr. John M. Campbell.

Bibliography

1. Campbell, J. M., Skinner, W., and Laurence, L. L., *Petr. Ref.*, 31, 10, p. 106 (1952).
2. Amero, Moore, and Capell, *Chem. Eng. Prog.*, 43, 349, (1947).
3. Wilkinson, E. P. and Stark, B. J., *Gas Age*, May 25, 1940.
4. Hermann, R. H., Gas Processing Conf., Univ. of Okla., 1955.
5. Wilkinson, E. P., *Ibid*, 1952.
6. Getty, R. J., Lamb, C. E., and Montgomery, W. C., *Ibid*, 1953.
7. Aluminum Company of America, *Act. Alumina—Its Properties and Uses* (1949).
8. Floridin Company, *Adsorbents*.
9. Socony Vacuum Oil Company, *Sovabead Techn.*
10. Heineman, H., Krieger, K. A., and McCarter, W. S. W., *Ind. Eng. Chem.*, 38, 839 (1946).
11. McCarthy, E. L., Boyd, W. L., and Reid, L. S., *Jour. Petr. Techn.*, 241-52 (1950).
12. NGSMA Handbook, pp. 96 and 97 (1951).
13. Scheibel, E. G. and Jenny, F. J., *Petr Refiner*, p. 116, March, 1947, or NGSMA Handbook, Appendix (1951).
14. Buthod, P. and Whiteley, B., *Oil Gas Jour.*, 48, 21, 60, and 64 (1949).

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"DEVELOPING mechanical octanes is the art of balancing engine design, fuel octane requirements, and fuel octane ratings to permit knock-free operation at higher compression ratios on fuels now available." A combustion chamber design might offer good power characteristics, but have a high-octane requirement and rate fuel anti-knock quality low. Spark retarding may reduce the high-octane requirement to a desired level but also might result in a high power loss. The high power loss, however, might be tolerated if the mechanical octane numbers gained in the spark retarding procedure could be converted to a power advantage by increasing the compression ratio.

Condensation from Paper "Once More About Mechanical Octanes," given before SAE, January, 1956.

Combustion Chamber Performance Factors

Performance characteristics of four experimental combustion chambers are shown in Fig. 1. The top row of curves shows knock unlimited MBT (minimum spark advance for best torque) and knock limited power for a test Fuel A representing a premium grade commercial fuel.

MBT power for all four chambers is practically equal. However, knock limited power, MBT and borderline knock spark, MBT octane requirements, and engine ratings of Fuel A vary considerably.

Why do these combustion chambers differ so much in performance? They all require spark retarding to bring the octane requirement down to the borderline knock level of Fuel A. Accordingly, the combustion chamber with the highest octane requirement would be expected to need most spark retarding and show the lowest power on Fuel A, and so forth. Knock limited power would be expected to in order of Chambers II, I, III, and IV, going from low to high. Actually, Chamber II shows higher knock limited power than Chamber I, while Chambers III and IV are approximately equal.

One reason for higher knock limited power in Chamber II is that this chamber rates Fuel A higher than does Chamber I. It needs less spark retarding. Also Chamber III does not show lower than expected, but approximately the same knock limited power as Chamber IV because it rates Fuel A higher.

Another reason for more knock limited power in Chamber II is that it loses less power for the same amount of spark retarding.

Fig. 2 shows power loss vs octane-requirement curves obtained by spark retarding at 1200 rpm. The slope of

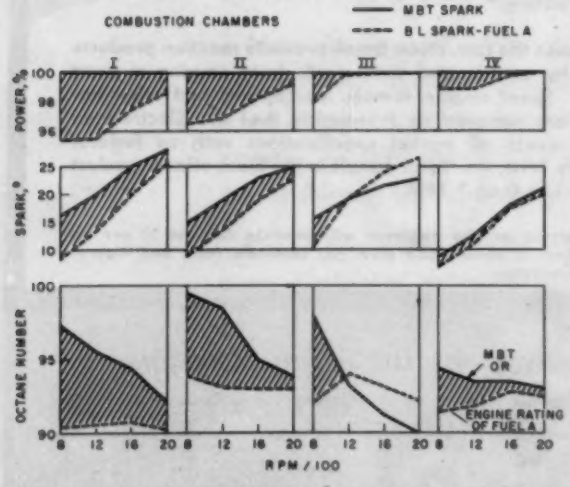


FIG. 1. Curves showing performance characteristics of four experimental chambers.

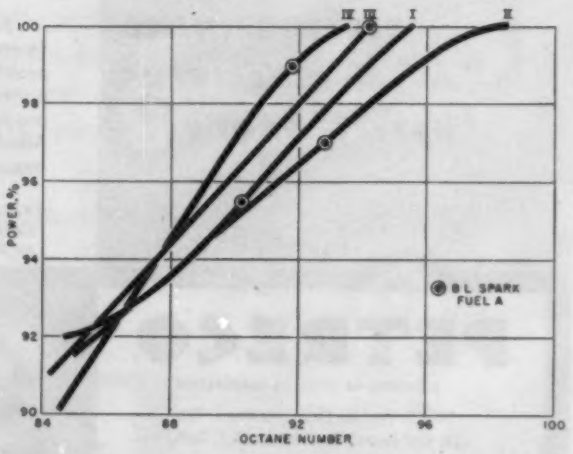
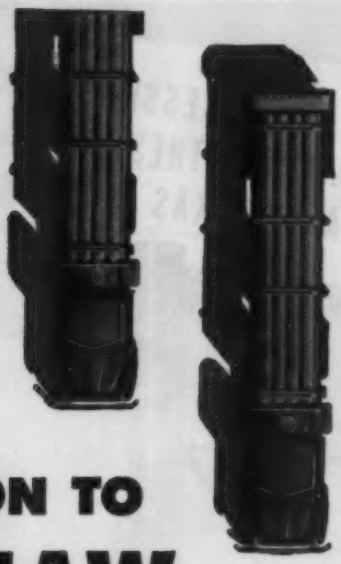


FIG. 2. Power loss compared to octane requirement obtained by retarding spark at 1200 RPM.



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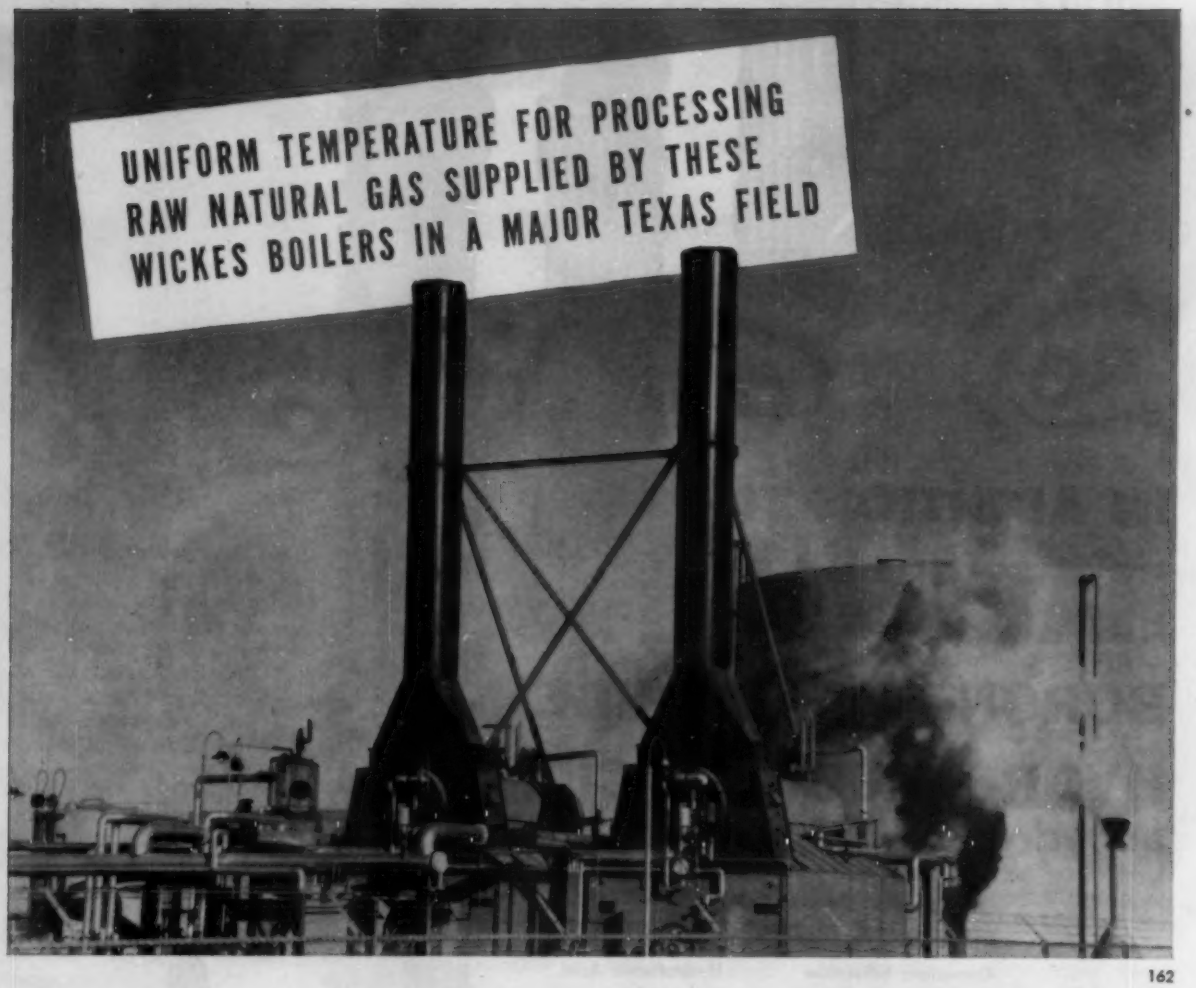

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Recently installed in the Texas field of a major petroleum producer, these two Wickes boilers assure delivery of the steam at proper uniform temperature and pressure to separate liquids and undesirable components. Wickes boilers are often chosen by petroleum companies, not only for field processing operations, but also for a dependable source of steam in refineries. The units shown here are Wickes Type A-2 shop-assembled water tube boilers, each with a design pressure of 275 psi and an operating pressure of 260 psi.

Other Wickes Type-A shop-assembled boilers are engineered for pressures up to 1,000 psi and steam temperatures up to 750°F., with sustained steam production up to 60,000 lbs. per hour. They are protected by pressure-tight steel casings which are completely weatherproof for outdoor installation. Throughout the petroleum industry, Wickes boilers are providing dependable, low-cost steam generation . . . for further information on Wickes units, consult your nearest Wickes representative or write for full facts.

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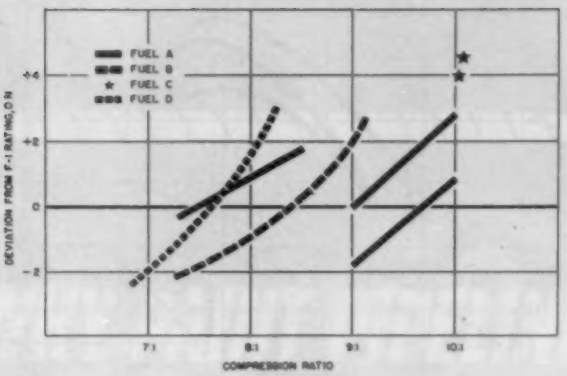

FIG. 3. Engine ratings of commercial fuels at various compression ratios.

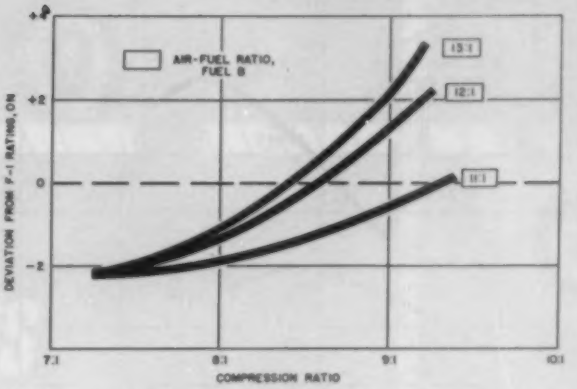

FIG. 4. Deviation of Fuel B octane ratings from F-1 values at different compression ratios.

these curves indicates the "power-octane ratio," that is the power loss per unit reduction in octane requirement. The MBT power points are shown as 100 per cent. The abscissae of these points are the MBT octane requirements. Chamber II shows higher MBT octane requirement than Chamber I. The slope of Chamber II curve, however, is lower. At spark retarded to approximately 93.5 per cent power, the octane requirement of both chambers is the same. Since in addition to the lower slope of its power-octane curve, Chamber II rates Fuel A higher, a considerable power gain results.

Fuel Octane Ratings at Increased Compression Ratios

We generally rate commercial fuels higher at increased compression ratios. Two factors might account for this increase: (1) Cooler engine operation due to higher gas expansion and (2) spark retarding to borderline knock of the fuel, which also results in lower end gas temperature. The gains in fuel rating can be considerable.

Fig. 3 shows engine ratings of commercial gasolines and commercial-type reference fuels of various octane levels in terms of octane depreciation or appreciation against the CFR engine F-1 ratings. The ratings are plotted vs compression ratio. Each curve represents ratings of the same fuel in the same engine at various compression ratios. Fuel ratings increase by as much as 5.5 octane numbers.

In Fig. 4, ratings of Fuel B are shown at 13:1, 12:1 and 11:1 air-fuel ratio. Apparently, at richer mixture settings increases in compression ratio result in less gain in fuel ratings.

Increased compression ratios had an adverse effect on power-octane ratios. In Fig. 5, power vs octane curves are plotted for a 6-cyl overhead valve engine at 7.3:1, 8.1:1, 8.7:1 and 9.1:1 compression ratio. The slopes of these curves become steeper as the compression ratio is raised.

Balancing for Optimum Performance

In addition to spark retarding, mixture richening is an effective means for gaining mechanical octanes. While mixture richening would appear to result in lower fuel economy, it should be remembered that it is only applied at WOT during the engine speeds at which knock is encountered. Overall fuel economy is usually little affected by full-load, low-speed mixture richening, and even is improved when the mechanical octanes gained result in the use of a higher compression ratio.

In shooting for optimum-knock limited power and optimum thermal efficiency, first a combustion chamber has to be selected of promising inherent characteristics. It should have low MBT octane requirement, rate commercial fuels high, and show low power-octane ratios within the applied spark setting range. It should respond well to compression ratio increases in regard to thermal efficiency.

Within the speed range in question, a balancing procedure could then be applied as shown in an example.

As the first step, power-octane curves are established for critical engine

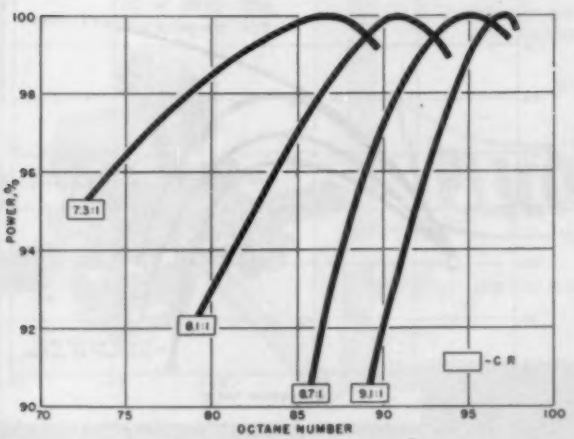

FIG. 5. Power-octane curves in a 6-cyl engine for four different compression ratios.

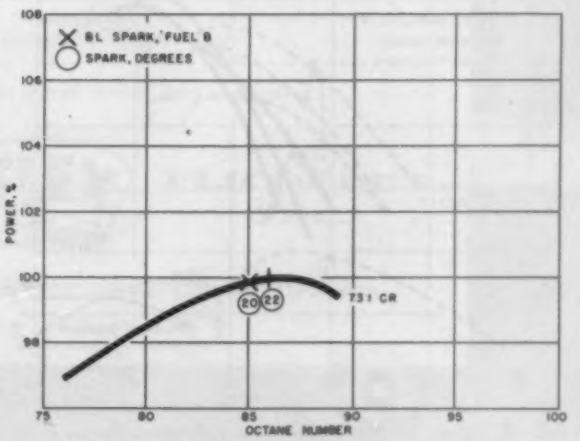

FIG. 6. Power-octane curve at standard compression ratio, 7.3:1.

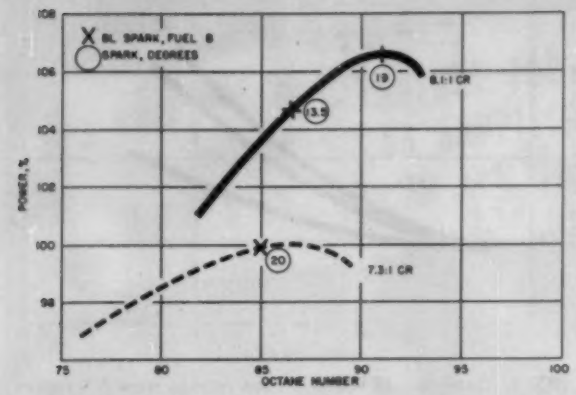

Fig. 7. Comparable power-octane curve for same engine and fuel at 8.1:1 ratios; 6.5 per cent more MBT power than is shown in Fig. 6.

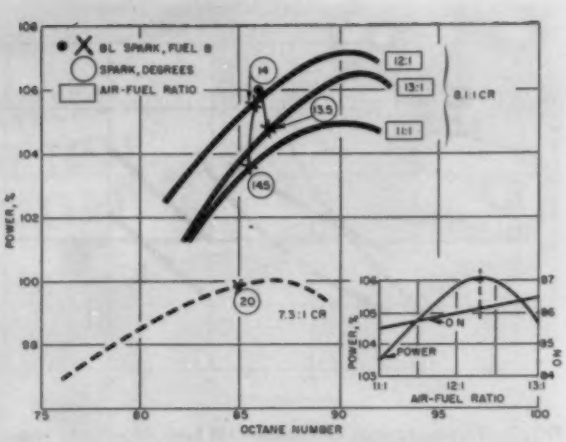

FIG. 8. With power-octane curves for three compression ratios, the peak appears at about 106 per cent, with air-fuel ratio of 12.3:1.

speeds. Fig. 6 shows such a curve at one speed and standard compression ratio. MBT octane requirement is 86. Fuel B rates 85 and renders practically MBT power. MBT spark is 22 deg and borderline spark for Fuel B is 20 deg.

As the second step, the compression ratio is raised by a certain increment, for instance to 8.1:1. The power-octane curve in Fig. 7 shows 6.5 per cent more MBT power. The engine rates Fuel B at 86.5 ON. Knock-limited power of Fuel B is about 5 per cent above MBT power at standard compression ratio.

In the next step, Fig. 8, power-octane curves are plotted for 13:1, 12:1 and 11:1 air-fuel ratio. The knock-limited power points at each air-fuel ratio are marked. The knock-limited power curve for Fuel B drawn through these points shows a peak at approximately 106 per cent power. Air-fuel ratio giving peak power is 12.3:1. The corresponding Fuel B rating is 86 ON. The exact peak is found by interpretation (see small plot on curve).

Procedure of step 3 is repeated in appropriate compression ratio increments until maximum power points or desired thermal efficiency levels are covered. In this example, the next compression ratio step was 8.7:1. The 3 solid curves on Fig. 9 show power vs octane again for 3 air-fuel ratios. At 13:1 air-fuel ratio, the Fuel B octane rating is 87.5. Knock-limited power is 101 per cent. Additional mixture richening results in 103 per cent knock-limited power, which is lower than the 106 per cent at 8.1:1 compression ratio. Obviously, at 8.7:1 compression ratios, we have passed the knock-limited power peak that can be obtained with Fuel B.

In Fig. 10, the result of the balancing procedure is shown as a plot of power vs compression ratio curves. The lower curve shows knock-limited power that can be obtained by retarding the spark and raising the compression ratio with a fuel of constant 85 engine rating. For instance, with a not sensitive straight-run gasoline that the engine rates 85 at all compression ratios. The next curve shows knock-limited power for Fuel B resulting from retarding the spark and raising the compression ratio. Due to the fact that Fuel B, being sensitive, rates higher than 85 ON at higher compression ratios, knock-limited power is higher. Procedure applied for the next curve differs from the previous one only in that mixture richening is added to spark retarding. The upper curve shows knock-unlimited MBT power at 13:1 air-fuel ratio. Knock-limited power peaks at approximately 8.2:1 compression ratio on all curves. The graph shows that in this example by spark retarding and mixture richening the engine can be operated at the tested speed knock free on Fuel B at 8.2:1 compression ratio

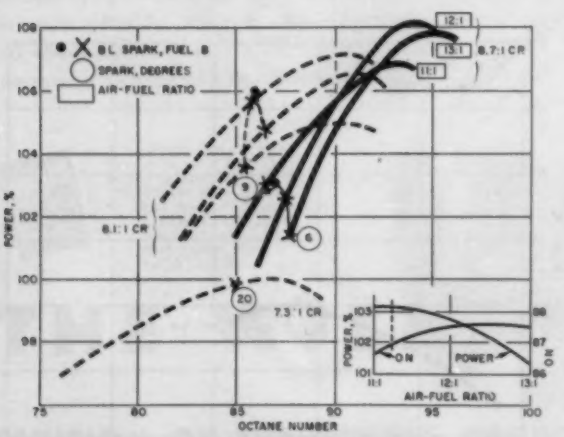

FIG. 9. Power-octane curves at 8.7:1 compression ratio show 103 per cent knock limited power, and shows that at this ratio the power peak for Fuel B has been passed.

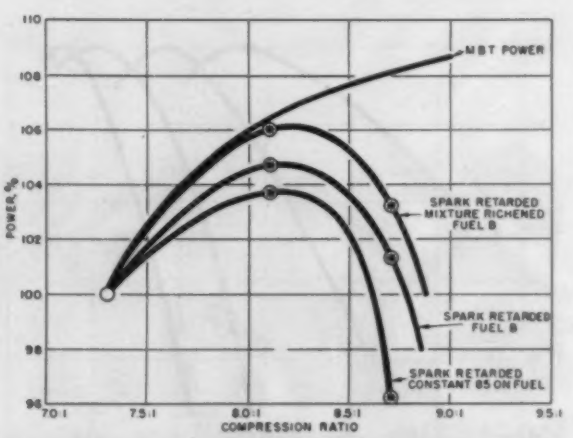

FIG. 10. By retarding spark and enriching the mixture, these curves show that peak power (6 per cent gain) can be had with Fuel B at 8.2:1, or with no power loss at 8.9:1.

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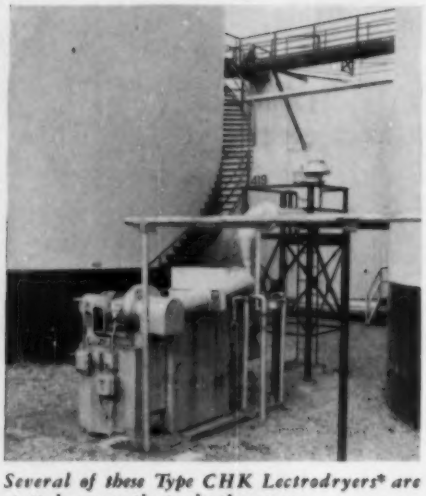

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with about 6 per cent gain in power, and furthermore, that the engine can be run knock free at approximately 8.9:1 compression ratio without any loss in power. When mainly shooting for fuel economy, 8.9:1 compression ratio will be the proper selection. At part load, the thermal efficiency potential of high compression ratios is fully utilized because optimum spark and carburetor settings can be applied.

This example, of course, presents the picture at one speed only for a clean combustion chamber. It has to be supplemented for other engine speeds and with deposit build-up. The compression ratio finally selected will be that determined at the most knock-critical speed. Also other considerations, including surface ignition and the proper safety allowance, will whittle down the potential gains somewhat further. * *

Fuels with higher sulfur, boiling end point and lower cetane number show greater engine wear and deposits.

P 266.

Future Use of Lower Quality Diesel Fuels

R. W. Seniff[1] and F. A. Robbins[2]
Coordinating Research Council

EIGHT full-scale field service tests in railroad diesel locomotives of fuels selected to investigate the effect of variations in sulfur content, ignition quality, and end point have been completed. These tests were conducted under the sponsorship of the Coordinating Research Council during the period May, 1949, to June, 1955.

This project was undertaken as a result of recommendation of the American Petroleum Institute and the Western Petroleum Refiners Association based on general concern for the future availability of straight-run fuels of 50 plus cetane number specified by most railroads. In 1946, the Coordinating Research Council established a group to survey current and future diesel fuel characteristics and to determine the possible future trends in diesel fuels likely to develop. A survey was likewise made covering the locomotive manufacturers' and railroad specification requirements for diesel fuels. The survey covering diesel fuel characteristics indicated that future diesel fuels in greatest supply would tend to be of higher sulfur content, lower cetane number, and higher final boiling point. Specifically, the predicted levels of these properties were 1.0 plus or minus 0.2 per cent sulfur content, 40 plus or minus 2 cetane number, 700 plus or minus F end point.

In each test, 2 or more similar locomotive units were used for approximately 1 year. The units were equally divided between test fuel, prepared as close as practical to the levels predicted in the fuel survey, and control fuel, which was the fuel normally used by the railroad. In each test, the test and control fuel units were assigned to similar service. Special precautions were taken to prevent mixing of test and control fuels. Since the locomotives were not new at the beginning of the tests, at least two precisely measured power assemblies, which consisted of pistons, rings, cylinders, cylinder heads, connecting rods, and related bearings, were installed in each engine. These measured assemblies were removed at the conclusion of the test and were measured and inspected to determine significant differences in deposits and wear.

The eight tests covered by the program involved a total of 34 diesel engines of three makes and were equivalent to approximately 38 engine-test years. Seventeen of these engines were operated on test fuels and 17 on control fuels. The test program covered approximately 2,500,000 unit-miles of combined high-speed passenger and average-duty to heavy-duty freight operation and 8000 hr of switching service. Approximately 2,500,000 gal of test fuel and an equivalent amount of control fuel were consumed during the tests. The following table gives a description of the diesel locomotive units employed in the study, the type of field service covered, and the conditions under which the equipment was operated. (See Fig. 23, SAE paper.) In addition to control analysis of fuel and lubricating oils during the tests, the U. S. Bureau of Mines, Petroleum Experimental Station at Bartlesville, Oklahoma, obtained analytical data on the distribution of sulfur and type of hydrocarbons throughout the boiling range of each fuel. Behavior of the fuels was also studied by them in the "Constant Volume Bomb" and the Bureau has offered that data as additional information.

Two independent laboratories volunteered test data on certain of the fuels in two and four-stroke cycle, small-scale engines. One laboratory used the same lubricating oils that were used in the railroad engines. The other used its standard straight-mineral test oil.

The following general results were established.

1. All eight full-scale railroad field tests produced data that could be interpreted with respect to the purpose of this project.

2. Use of test fuels did not affect locomotive performance or suitability for its assigned purpose. However, in order to keep test locomotives operating, in certain cases corrective measures had to be taken to overcome filter clogging caused by the high cloud and pour points of the fuel or injectors sticking caused by products of fuel instability that were deposited on injector plungers and barrels.

---

1. B.&O. R.R. Company
2. Koppers Company.
Condensed from SAE paper, "Full-Scale Field Service Tests of Railroad Diesel Fuels"; given before the SAE, January, 1956.

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3. The test fuel caused greater wear on deposits in seven out of the eight tests. The following tabulation indicates the number of locomotive units out of the 17 units on test fuel that had greater deposits or wear than the companion control fuel units.

Piston Skirt Lacquering (See Fig. 27, SAE paper.)	16
Cylinder Liner Bore Wear (See Fig. 39, SAE paper.)	12
Piston Ring Wear (See Fig. 40, SAE paper.)	11
Cylinder Liner Bore Deposits	9
Cylinder Liner Port Deposits	9
Wrist Pin Bushing Deposits	9
Rod Eye Wear	9
Valve Deposits	9
Injector Deposits	8
Ring Groove Wear	8
Ring Groove Deposits	5
Crankcase Deposits	5

It appears significant that no clear cut beneficial effect of test fuel was noted in any case except a minor instance in one test where the fuel strainers and filters were cleaner with the test fuel than the control fuel. Examination of the fuel oil analysis disclosed that this test fuel had a lower gum content than the control fuel used in this test.

4. The small engine investigations conducted on several of the test fuels and control-type fuels exhibited trends similar to those observed in the full-scale service tests with respect to deposits and wear.

The following conclusions can be drawn on the basis of the tests.

1. The overall approach to full-scale testing employed in this project appears to be a valid means of determining the effect of variation in fuel properties on railroad diesel engines.

2. Considering only the sulfur content, cetane number, and end point as physical properties of the test fuels, it was possible to operate the locomotive diesel engines under study without sacrificing locomotive availability.

3. In considering application of fuels of the type under test in this program, it should be noted that fuel properties other than sulfur content, cetane number, and end point may adversely affect locomotive operation or maintenance. Instability and high cloud and pour points are examples of such properties that were encountered in these tests.

4. Due to wear or deposits, increased engine maintenance such as more frequent change-out of power assemblies may result when using fuels of the type under test. This trend depends on the nature of the test fuel used, the nature of the locomotive operation, and maintenance practices, and was observed in 16 out of the 17 test-fuel engines. ★ ★ ★

P 758.

Inorganic thickeners have aerogel structures; soap greases have smoothly interconnected gel structures.

Structure of LUBRICATING GREASE Thickeners

A. L. McClellan and J. Cortes Jr.
California Research Corporation

LUBRICATING greases were first postulated to have an interlaced network of soap fibers almost 25 years ago.[1] These soap particles were observed in the optical microscope shortly thereafter by Farrington and Davis,[2] and within the past 10 years the use of the electron microscope has led to a much more intensive study of grease thickeners.[3] A new way of isolating the grease fibers has been used recently[4] to give an isolated sample of undisturbed fibers called an aerogel. This paper describes the procedure for making aerogels on electron microscope screens and the appearance of lattices prepared this way.

Conventional method for making specimens for examination in the electron microscope consists of diluting the grease with oil, placing a small sample of the mixture on a membrane-covered screen, then replacing the oil by washing with a volatile solvent.[3] This dispersion method, while convenient, destroys the three-dimensional structure of the thickener material in three ways. The mechanical working involved in stirring the oil into the grease causes breakdown of the lattice. The addition of oil breaks up more of the lattice by forcing it to accommodate more oil. Finally, the surface tension, as the solvent surface recedes through the thickener lattice during drying, is sufficient to collapse the remaining structure. Several investigators[4,5] have reported the destructive effects of this drying procedure.

The basic method for the preparation of aerogels was devised by Kistler[6] and recently modified for biological specimens[7] and hydrocarbon-soap gels.[4] We applied the method to nine lubricating greases, four gelled with inorganic materials and five with soaps. Electron micrographs of samples prepared by this improved technique give a different view of the thickener structure, partly because the fibers are undisturbed and partly because they are not shadowed with metal. The advantage of viewing undisturbed fibers overbalances the loss in structure detail in unshadowed material.

An aerogel is prepared directly as an electron microscope sample as follows: A screen without a supporting membrane is packed with grease, and the excess is scraped off both sides simultaneously by passing the screen between two inclined razor blades. The screens are mounted in a holder and placed in an autoclave, together with a small basket of grease, to serve as visual proof of the successful production of the aerogel by the process described above.

Inorganic Thickeners

Lubricating greases can be made with a variety of inorganic solids if both particle size and oleophilic nature are properly adjusted. The present trend toward high dropping point, a property largely determined by the melting point of the thickener, makes these inorganic materials particularly interesting.

Fig. 1 shows esterified silicic acid (Du Pont Estersil GT) particles. The individual particles are very small spheroids, about 0.01μ in diameter. Some agglomeration is present in the dispersed sample, but discontinuities are apparent.

Carbon black (Shawinigan acetylene black) formed a gel structure similar to that of Estersil. In the dispersed samples of treated bentonite clay (Bentone 34), the plate-like material was flattened to the supporting membrane by the evaporation of the solvent. In contrast, the aerogel had numerous in-

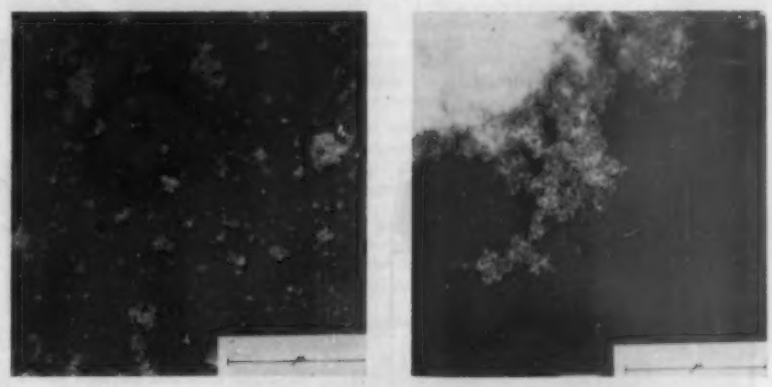

FIG. 1. Dispersion (left) and aerogel forms of estersils (silicic acid esters).

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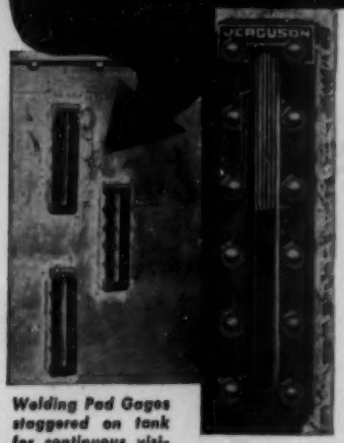

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terstices formed by the disordered stacking of the platelets. The aerogel of purified attapulgite clay (Permagel) showed a random stacking, or "jackstraw," type of gel lattice. None of these inorganic aerogels gave indication of growing together into a coherent maze of fibers.

In Fig. 2, the fibrous nature of sodium "tallowate" thickener is clearly demonstrated. The aerogel is a continuous maze in which individual fibers are not identifiable. The fact that dispersed samples seldom show branched fibers indicates that the network junctions are more susceptible to rupture than the fibers themselves. Lithium stearate aerogel showed the same type of structure. The continuity of the soap mesh is characteristic of soap aerogels.

In Fig. 3, the dispersed sample shows the helicoid form that is characteristic

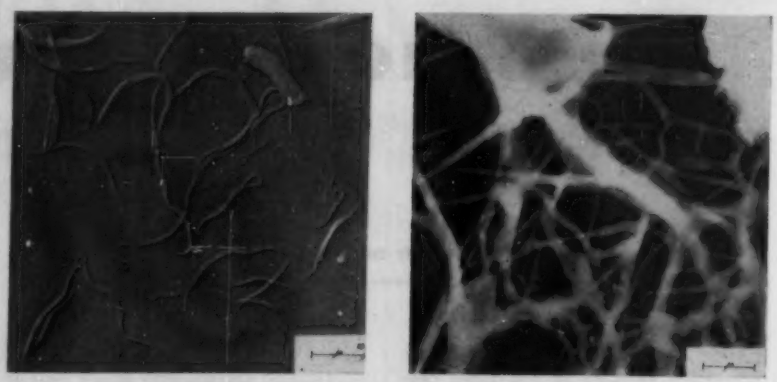

FIG. 2. Dispersion and aerogel forms of sodium "tallowate" showing its fibrous nature, and the continuous maze of the aerogel.

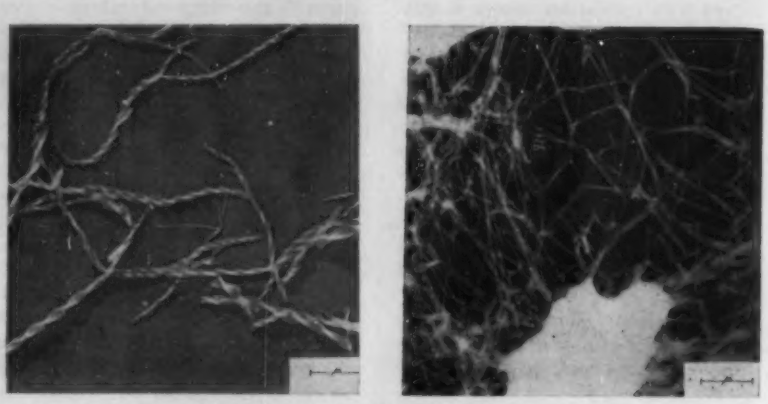

FIG. 3. Dispersion and aerogel forms of lithium 12-hydroxystearate, showing the "helicoid" form the dispersion and less twist in the aerogel.

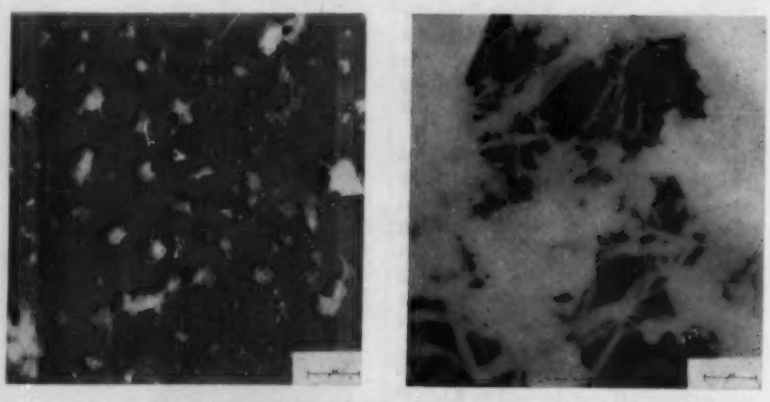

FIG. 4. Dispersion and aerogel forms of aluminum stearate, showing very small dispersed particles and the fibrous nature of the aerogel.

of this soap when prepared in this way. The aerogel has distinctly less twist in the areas between junctions. In the many photomicrographs examined, occasional fibers held in the lattice by only one end showed the usual twisted form.

Other micrographs (not reproduced here) showed the results of some combinations of the two methods to show that the aerogel process itself is not responsible for the fiber shape change. First, a sample of fibers prepared by the usual dispersion method was observed to have the characteristic helicoids. The specimen next was carried through the aerogel forming process. A true aerogel could not form because the fibers were already separated by the dispersion treatment, but the twisted shape was still present after this treatment. The aerogel treatment did not untwist the fibers. In another experiment, the grease was diluted with oil, placed on the collodion membrane, and the oil removed by the aerogel method. The twisted fibers were still found.

In the four experiments on lithium 12-hydroxystearate, the twisted fiber form was observed in the three cases that involved mechanical breakdown through dilution and working. Presence of the solvents and elimination of the receding meniscus do not explain different structures. Thus, we conclude that mechanical factors are of primary importance in causing fiber twisting.

The same series of preparation tests described above for lithium 12-hydroxystearate was carried out with calcium "tallowate." The same result was obtained; rupture of matrix was required for the occurrence of the twisted fiber form.

Optical miscroscope and electron microscope studies show that the aluminum stearate particles from dispersed samples are very small.[2] Aerogels made from this grease reveal a fibrous structure in common with the general structural type found for soap thickeners.

Discussion

The observation that the aerogels of lithium 12-hydroxystearate and calcium "tallowate" do not show the same twisted structures as the isolated fibers was reported previously.[5] Actually, the nontwisted form is the expected one, and the occurrence of twisted soap fibers requires an explanation of this less common crystal form. Helicoid crystal shapes are not unique to soap fibers but have been observed for many materials.[9]

Wilman[9] explains such structures as the result of rotational slip of crystal layers parallel to the cleavage plane. In

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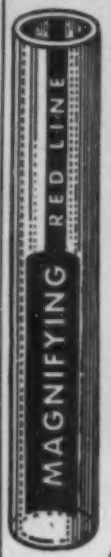

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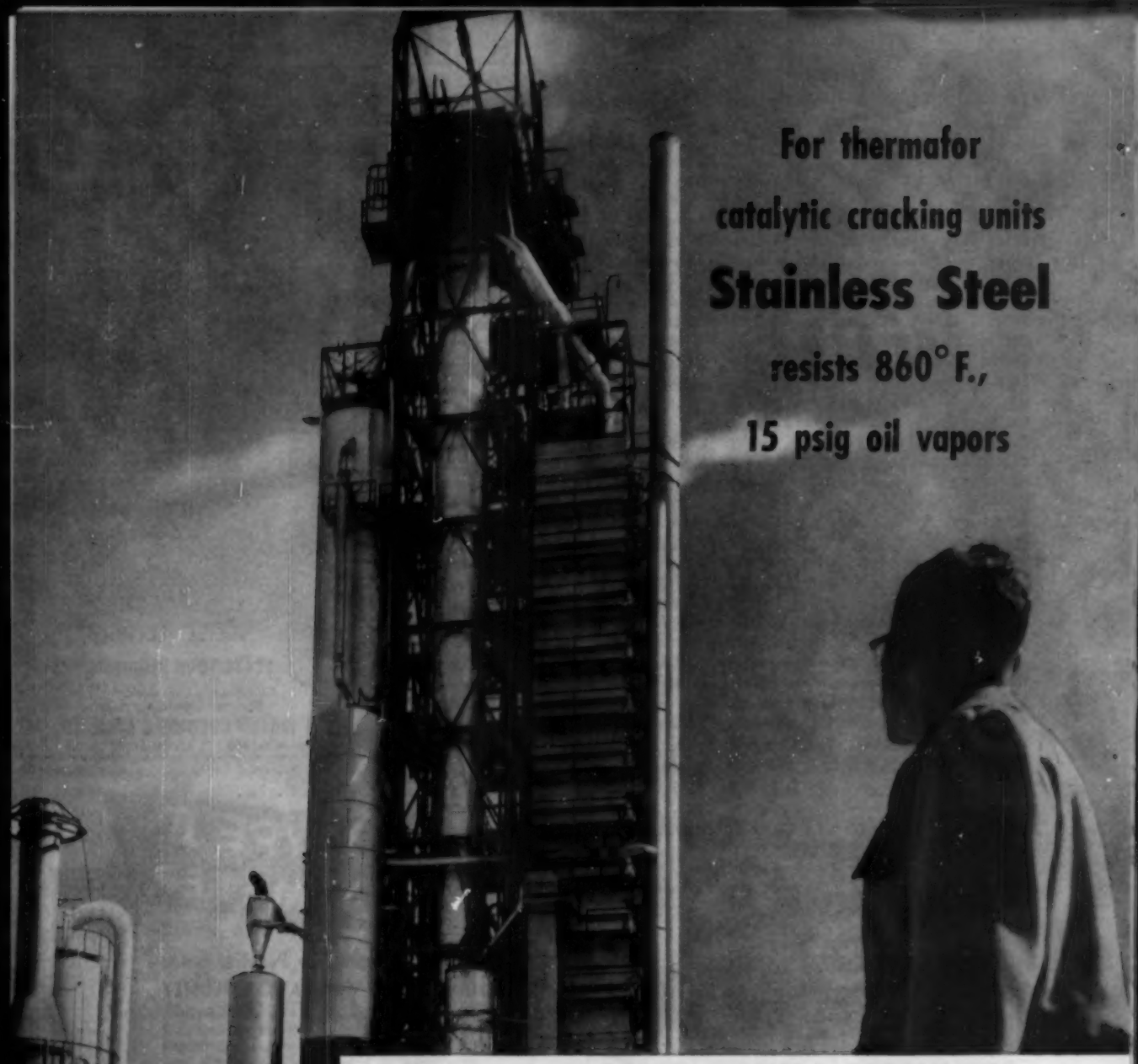

For thermafor catalytic cracking units **Stainless Steel** resists 860°F., 15 psig oil vapors

How different refineries would be without Stainless Steel! And how much *more* they would cost to operate! Almost every time you find a high temperature, corrosive situation, you find lots of Stainless Steel.

In the unit shown here, the reactor chamber is lined with 7/64" type 410 Stainless. Reactor internals, bubble caps and trays and various vessel linings are also made from Stainless Steel. These are decisive steps to reduce the continuing high cost of refinery plant corrosion.

When *buying* Stainless Steel, remember that United States Steel offers the widest range of sizes, grades and types. Selection is easy, and you can be sure of service-tested USS quality.

El Dorado, Arkansas refinery of Lion Oil Company, a division of Monsanto Chemical Company.

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his opinion, the rotation can be caused by growth conditions or by deformation. Our finding that the spiral forms are more prevalent after mechanical breakdown agrees with Wilman's data.

Wilman also commented on the wide range of force needed to produce rotational slip in the materials from which he prepared spiral crystals. We can postulate that lithium 12-hydroxystearate and calcium "tallowate" require less deformation force to cause spirals than other soaps. It is interesting that these two thickeners each have, in the hydroxyl group and the associated water, a disrupting influence that may make these crystals more susceptible to rotational slip.

Summary

1. The thickening materials from lubricating greases were isolated and examined without change of lattice structure.

2. Inorganic thickeners have aerogel structures that would be expected from the form of the individual particles.

3. The soap-thickened greases have a gel structure that is smoothly interconnected in a manner that leaves essentially no free ends. In contrast, the inorganic materials have tangled masses of identifiable fibers or agglomerations of spheroids.

4. The twisting observed for isolated fibers of lithium 12-hydroxystearate and calcium "tallowate" is not prominent in the continuous gel structure. The twisted forms are probably the result of mechanical breakdown that separates the fibers at the gel junctions.

5. A continuous, fibrous structure was observed in aluminum stearate aerogels.

References

1. Arveson, M. H., *Ind. Eng. Chem. 24*, 71 (1932).
2. Farrington, B. B., and Davis, W. N., *Ind. Eng. Chem. 28*, 414 (1936).
3. Farrington, B. B., and Birdsall, D. H., *Inst. Spokesman 11*, No. 1, 4 (1947).
4. Peterson, W. H., and Bondi, A., *J. Phys. Chem. 57*, 30 (1953).
5. Browning, G. V., *Inst. Spokesman 14*, No. 1, 10 (1950).
6. Kistler, S. S., *J. Phys. Chem. 36*, 52 (1932).
7. Anderson, T. F., Trans. N. Y. Acad. Sci. 13, 130 (1951).
8. Vold, R. D., Coffer, H. F., and Baker, R. F., *Inst. Spokesman 15*, No. 10, 8 (1952).
9. Wilman, H., *Proc. Phys. Soc. 64*, 329 (1951).

★ ★ ★

This Ampco Pipe has a ¾" wall, to handle sulphuric acid sludge in oil-company operation.

Sulphuric Acid Sludge No Problem

for major oil company,* in 1000-lb. transfer service

Its Ampco Pipe and Fittings resist corrosion

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Phenols

Furfural

Brine

*Name upon request

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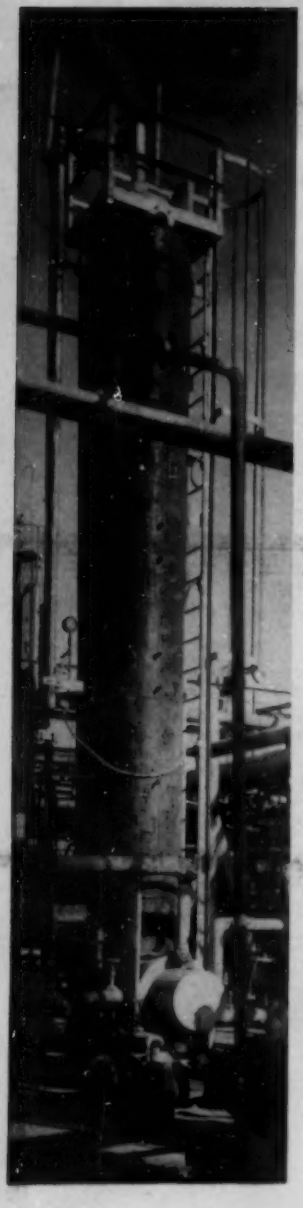

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East Coast Shows Highest Octane Number Levels

Gasoline on sale at service stations in March showed a national weighted average of 96.4 octane number for premium and 89.3 octane number for regular, according to the latest monthly survey of antiknock quality compiled by Ethyl Corporation.

The premium gasoline average was unchanged from February and was 1.5 octane number higher than in March, 1955. The regular gasoline average was up 0.1 octane number from February and 1.8 octane number higher than a year ago.

Average tetraethyl lead contents in March were 2.47 ml per gallon of premium gasoline and 2.22 ml per gallon of regular gasoline.

Twenty of the 53 cities covered by Ethyl's survey reported increases over February in the average octane number of their premium gasoline, with one city showing a monthly gain of 0.5 octane number. Nineteen cities reported decreases while 14 cities were unchanged. In regular gasoline, 29 cities reported increases in their average antiknock quality, 6 of them by 0.5 octane number or more. Sixteen cities showed a decrease from February while 8 cities were unchanged.

Compared with the nationwide premium average of 96.4 octane number, 18 cities reported premium averages of 97 octane number or higher. In regular gasoline, 15 cities showed average octane ratings of 90 octane number or higher, compared with the national weighted average of 89.3 octane number.

Average Research Octane Number

	Premium Gasoline March, 1956	Regular Gasoline March, 1956
Albuquerque, New Mexico	95.8	86.4
Amarillo, Texas	96.6	87.5
Atlanta, Georgia	97.6	89.4
Bakersfield, California	95.7	85.8
Baltimore, Maryland	97.2	91.2
Billings, Montana	93.9	86.6
Birmingham, Alabama	97.5	89.2
Boston, Massachusetts	97.5	91.5
Buffalo, New York	97.5	91.5
Casper, Wyoming	92.7	85.3
Central Michigan	95.8	89.7
Charlotte, North Carolina	97.4	89.4
Chicago, Illinois	95.3	88.4
Cincinnati, Ohio	95.8	91.0
Cleveland, Ohio	95.7	90.9
Corpus Christi, Texas	97.1	89.2
Dallas-Fort Worth, Texas	97.3	89.1
Denver, Colorado	92.4	84.3
Detroit, Michigan	95 5	90.3
El Paso, Texas	95.3	86.5
Fargo, North Dakota	93.6	85.6
Hartford, Connecticut	97.1	91.7
Houston, Texas	97.0	88.3
Indianapolis, Indiana	95.6	90.0
Jackson, Mississippi	97.3	89.1
Jacksonville, Florida	97.3	90.7
Kansas City, Missouri	94.2	86.7
Little Rock, Arkansas	97.1	89.2
Los Angeles, California	96.2	86.2
Louisville, Kentucky	96.6	89.2
Memphis, Tennessee	97.3	89.4
Metropolitan New York-New Jersey	97.2	91.5
Milwaukee, Wisconsin	95.4	89.1
Minneapolis-St. Paul, Minnesota	94.6	86.7
New Orleans, Louisiana	96.8	89.0
Northwest Pennsylvania	95.7	91.0
Oklahoma City, Oklahoma	94.5	86.2
Omaha, Nebraska	93.9	86.0
Philadelphia, Pennsylvania	96.9	91.5
Phoenix, Arizona	96.6	87.0
Pittsburgh, Pennsylvania	97.5	92.2
Portland, Oregon	96.2	86.9
Richmond, Virginia	97.5	91.4
Salt Lake City, Utah	93.0	82.2
San Antonio, Texas	96.8	88.5
San Francisco, California	96.2	86.5
Seattle, Washington	96.0	86.5
Shreveport, Louisiana	97.2	88.7
Spokane, Washington	95.7	86.7
St. Louis, Missouri	94.2	86.5
Toledo, Ohio	95.8	90.9
Tulsa, Oklahoma	94.5	86.5
Wichita, Kansas	93.9	86.2

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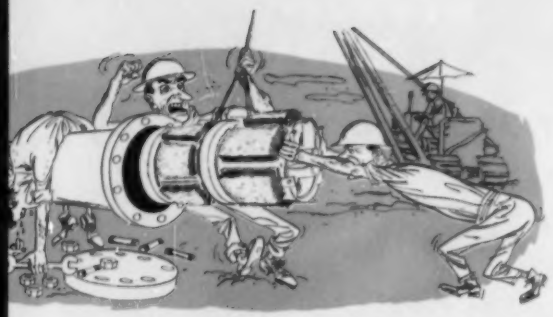

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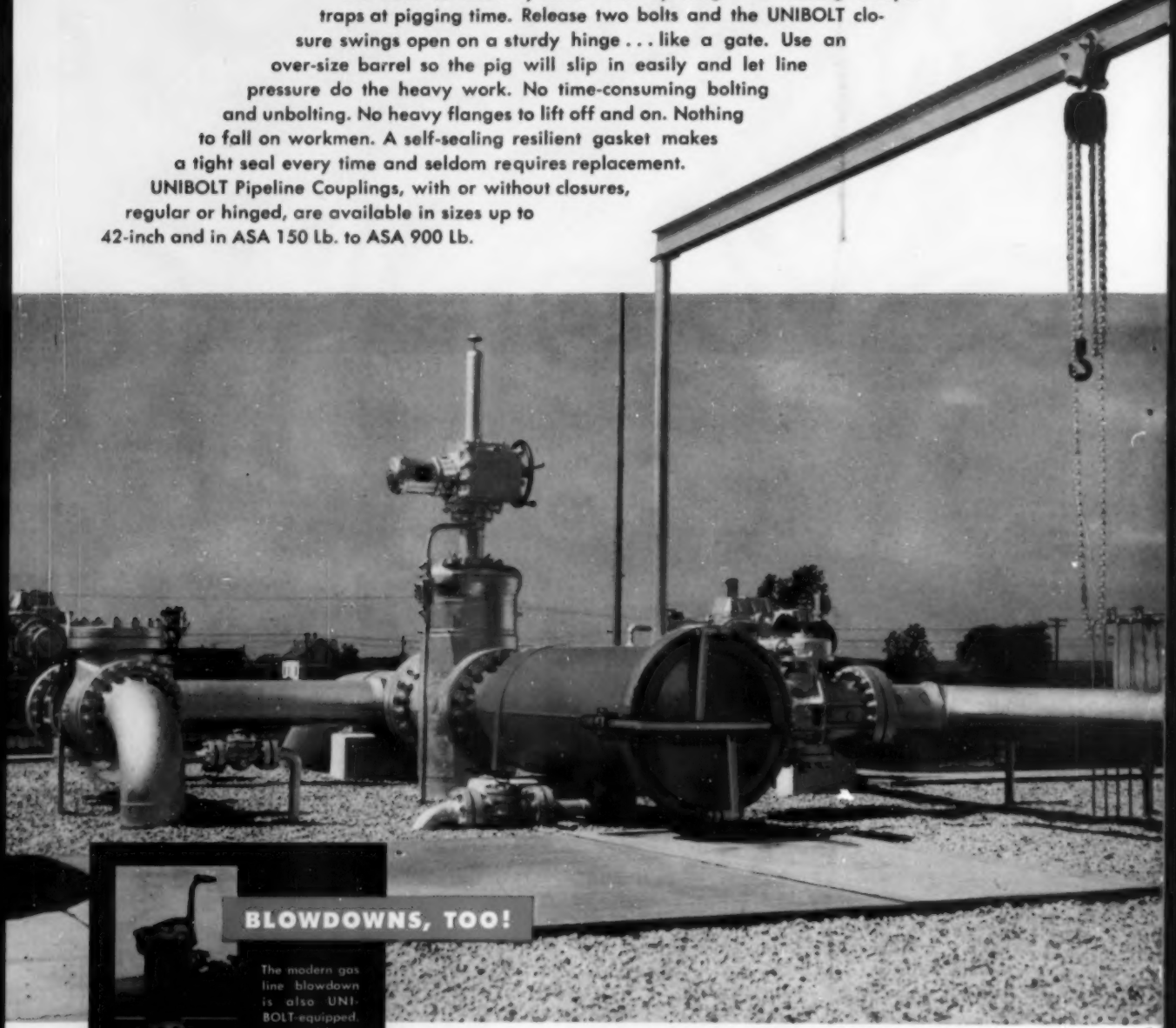

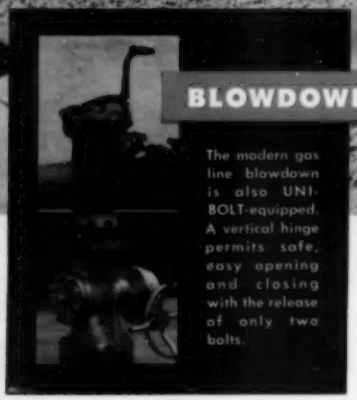

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PIPE LINE DEVELOPMENTS ★ ★ ★

Roundup of Current Planned and Proposed Construction

The following tables list the company, mileage, pipe size, and location of proposed pipe line projects — crude, products, and natural gas — reported to The Petroleum Engineer. Company addresses are given where furnished or known.

CRUDE LINES

Name of Company	Miles	Size	Location
Ar-Mex Pipe Line Company, Dallas, Texas	790	12-14	Guernsey, Wyoming to Coolidge, Arizona
Kaybee Pipe Line Company, Muskegon, Michigan	46	10	Griffith, Indiana to New Buffalo, Michigan
Michi, Inc., Detroit, Michigan	222	10	Highland, Indiana to Alma, Michigan
National Co-Operative Refinery Association, Kansas City, Missouri	30	8	Lyons to McPherson, Kansas
Offshore Gathering Company, Houston, Texas	364	20	Offshore line in Gulf of Mexico from Sabine Pass to Mississippi River
Pasotex Pipe Line Company, Houston, Texas	76	20	Wink to El Paso, Texas, to replace smaller system
Powder River Pipe Line Company, Casper, Wyoming	436	10-16	Williston Basin to Laurel-Billings, Montana, refining area
Sinclair Pipe Line Company, Independence, Kansas	150	20	Mexia to Houston, Texas. Replacement of existing line
	12	6	North Madill field to Cumberland field terminal, Oklahoma
Stanmount Pipe Line Company	140	10	Beaver Lake field, North Dakota to Cromer, Manitoba station on Interprovincial Pipe Line
Tecumseh Pipe Line Company	—	20	New line between East Chicago, Indiana, to Cygnet, Ohio
Trans-Border Pipe Line Company	110	—	Skagway, Alaska to Whitehorse, Yukon, Territory
Trans-Prairie Pipe Lines, Ltd., Winnipeg, Manitoba	17	3-6	Lines in Cromer and Virden areas, Manitoba
Union Oil Company, Los Angeles, California	815	—	Considering line from shale oil plant at Rifle, Colorado, to Los Angeles area
U. S. Department of Defense	97	—	Crude line from Elk Hills Naval Reserve to Los Angeles

PRODUCTS LINES

Name of Company	Miles	Size	Location
Ar-Mex Pipe Line Company, Dallas, Texas	60	8	Coolidge to Phoenix, Arizona
	70	8	Coolidge to Tucson, Arizona
Bell Oil and Gas Company, Tulsa, Oklahoma	140	6-8	Ardmore to Cushing, Oklahoma
California-Oregon Pipe Line System, Crescent City, California	103	6	Crescent City, California to Medford, Oregon
Deep Rock Gas Company (LPG Line)	120	6	Tioga, North Dakota to U. S.-Canadian Border
El Paso Natural Gas Company, El Paso, Texas (LPG Line)	60	10	Farmington to Gallup, New Mexico
International Pipe Line, Inc., Minneapolis, Minnesota	132	8	Wrenthall to Minneapolis, Minnesota
Malco Pipe Line, Inc., Roswell, New Mexico	91	6	Prewitt to Albuquerque, New Mexico
	138	6	Artesia to Newman, New Mexico
Mayflower Pipe Line Company	400	10	New Jersey refineries to New England points
Moore-Stoner Company	200	6	Glendive, Montana to Minot, North Dakota
Phillips Pipe Line Company, Bartlesville, Oklahoma	50	12	Sweeny to Pasadena, Texas, refinery near Houston
Sioux Oil Company	50	6	Newcastle, Wyoming to Rapid City, South Dakota
Texas Eastern Transmission Corporation, Shreveport, Louisiana	1168	16-20	Plans to convert the "Little Inch" line between Beaumont, Texas and Moundsville, West Virginia upon completion of new gas facilities. Has FPC aproval to abandon gas service from the "Little Inch"
Winnipeg & Central Gas Company, Winnipeg, Manitoba (LPG Line)	210	6	U. S.-Canadian border to Winnipeg (See also Deep Rock Gas Company listing)

GAS LINES

Name of Company	Miles	Size	Location
Alberta Gas Trunkline, Calgary, Alberta	315	6-34	Gas gathering system in Alberta fields to serve proposed Trans Canada Pipe Lines
American Louisiana Pipe Line Company, Detroit, Michigan	117	22	Defiance, Ohio to Bridgman, Michigan
Arkansas-Louisiana Gas Company, Shreveport, Louisiana	76	24	Loops in Louisiana
Atlantic Seaboard Corporation, Charleston, Virginia	31	—	Parallel existing line in West Virginia and Virginia
	55	—	Interconnecting lines between Lost River station, Hardy County, West Virginia and Bickers station in Greene Virginia
Carolina Natural Gas Corporation	185	2-12	Lines in North and South Carolinas

This GTD-300 Trenchdril suspended from a tractor boom is the last word in drilling efficiency and mobility. Maximum penetration is obtained by the combination of powerful feed, strong rotation and the constant air blast which gets you quickly through dirt capping and the broken surface formations.

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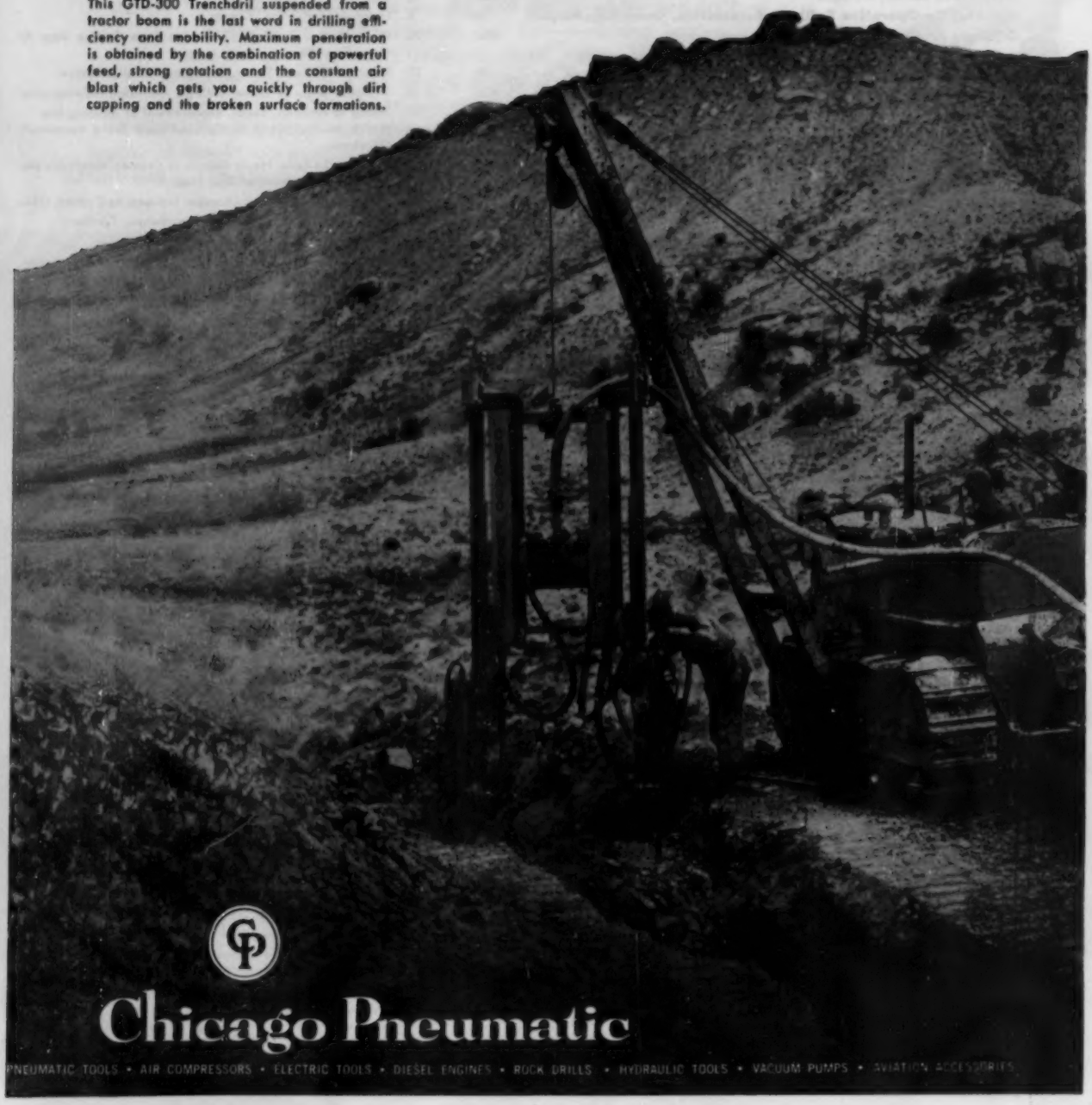
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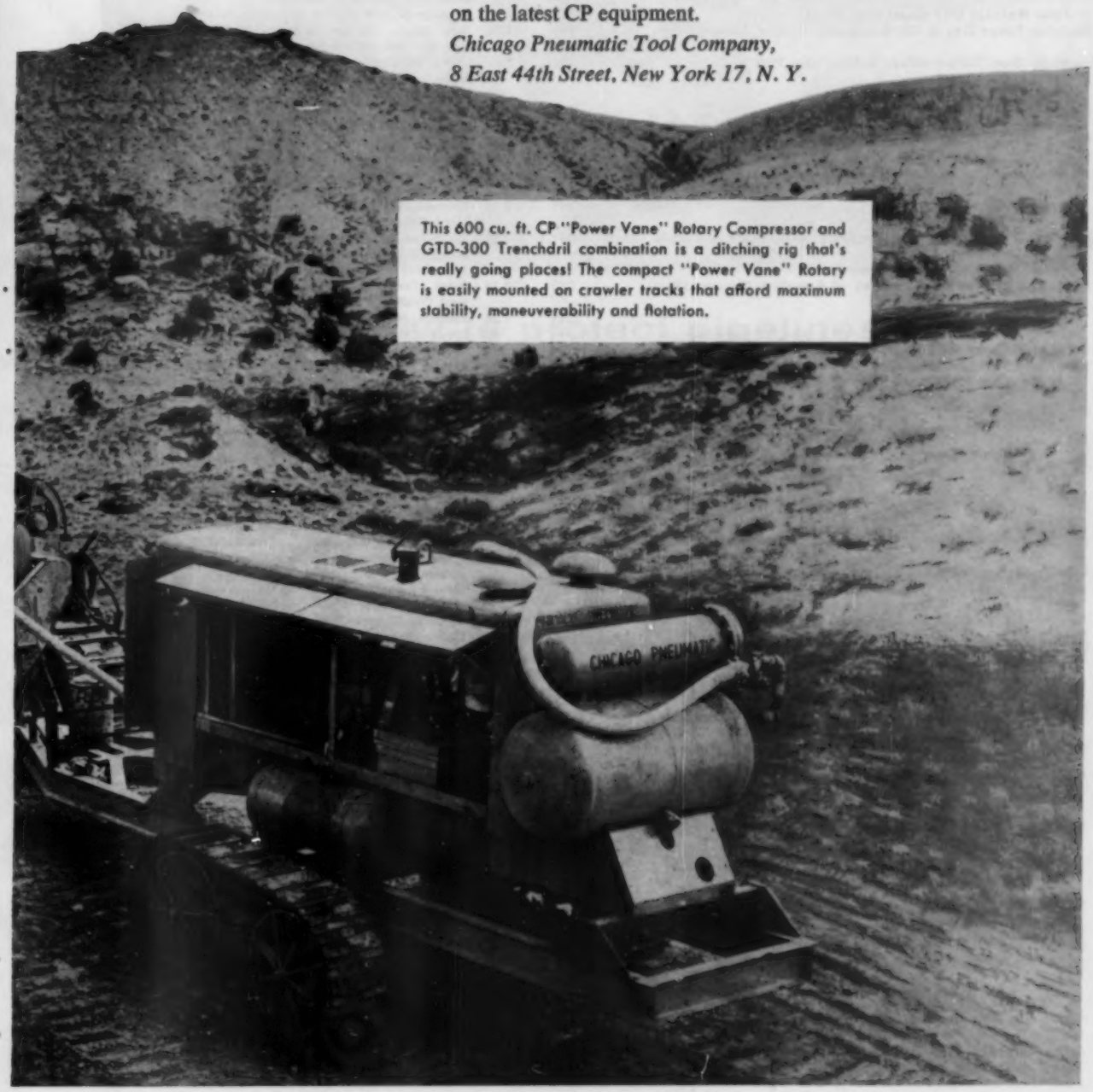
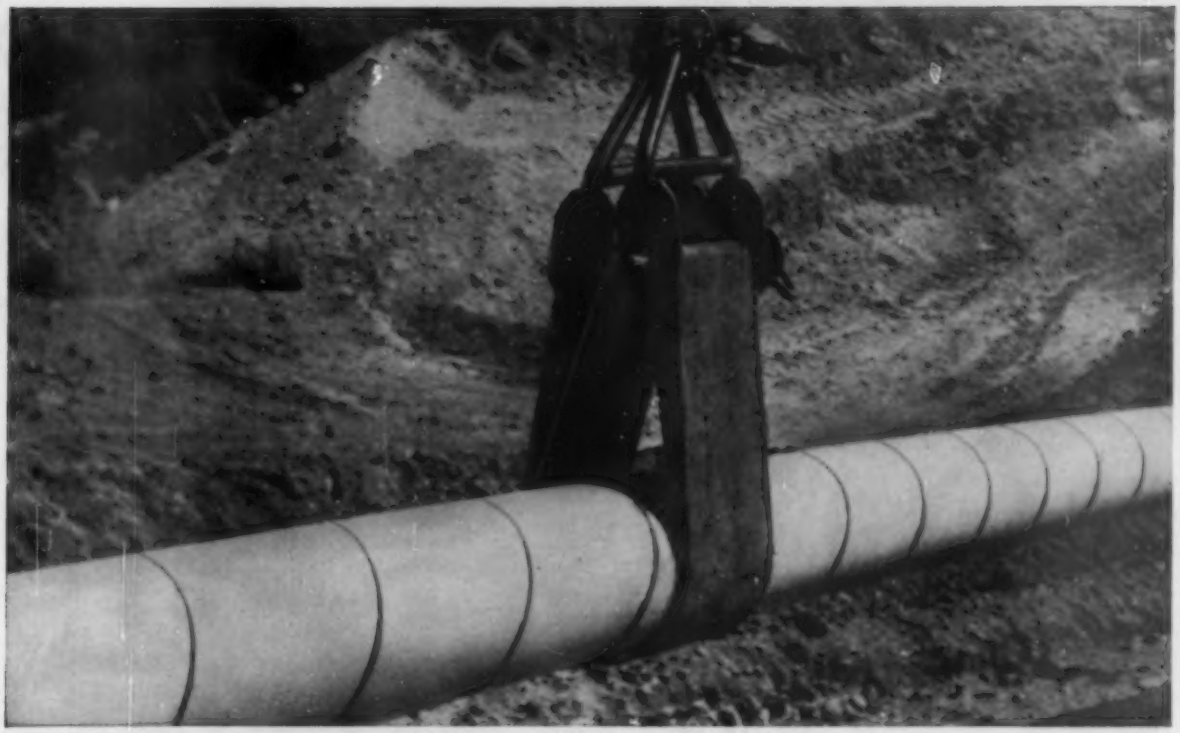


This 600 cu. ft. CP "Power Vane" Rotary Compressor and GTD-300 Trenchdril combination is a ditching rig that's really going places! The compact "Power Vane" Rotary is easily mounted on crawler tracks that afford maximum stability, maneuverability and flotation.

GAS LINES (Continued)

Name of Company	Miles	Size	Location
Central Hudson Gas & Electric Corporation, Albany, New York	48	12	Albany to Kingston, New York
Central Kentucky Natural Gas Company, Charleston, West Virginia	21.1	20-24	New lines in Kentucky
Cities Service Oil Company, Bartlesville, Oklahoma	70	—	Gas gathering system on the Roberts Ranch, Midland County, Texas
Coastal Transmission Corporation, Dallas, Texas	562	22-26	McAllen, Texas to Baton Rouge, Louisiana
	272	Var.	Gathering lines in Rio Grande Valley, Texas
Colorado Interstate Gas Company, Colorado Springs, Colorado	110	6-8	Julesburg area to Denver, Colorado
	307	30	Main line between Idalia, Colorado and Beatrice, Nebraska.
	160	26	Lateral between Carr, Colorado and Idalia.
	75	26	Lateral between Kit Carson, Colorado and Idalia.
	215	20-26	Parallel existing line between Texas and Oklahoma Panhandle gas fields and Kit Carson, Colorado.
	34	16	Gathering lines from Keyes field, Oklahoma and Greenwood field, Kansas to new line.
El Paso Natural Gas Company, El Paso, Texas	547	34	Farmington, New Mexico to Topock, Arizona
Houston Texas Gas & Oil Company, Houston, Texas	961	12-20	Baton Rouge, Louisiana to Miami, Florida, serving Florida area with various laterals
Iroquois Gas Corporation, Buffalo, New York	36	Var.	Gathering and delivery lines in underground storage area in Chautauqua, Cattaraugus and Erie Counties, New York
Lone Star Gas Company, Dallas, Texas	230	30	Cotton County, Oklahoma to Fritch, Texas
	205	24	Snyder, Texas to Cotton-Fritch line
Michigan-Wisconsin Pipe Line, Detroit, Michigan	724	4-24	Loops on system in Missouri, Iowa, Illinois, and Wisconsin
Michigan-Consolidated Gas Company, Detroit, Michigan	25	12	Sparta to Muskegon, Michigan
Midwestern Gas Transmission Company, Houston, Texas	1112	12-24	Main line from U. S.-Canadian Border near Emerson, Manitoba-Noyes, Minnesota to Portland, Tennessee
	648	3-18	Laterals off main line to serve communities in Minnesota, North Dakota, and Wisconsin
Montana-Dakota Utilities Company, Minneapolis, Minnesota	41.8	12	Tioga-Beaver Lodge field in North Dakota to main transmission line
Morganfield Natural Gas Company	31	4-6	New lines in Kentucky
Natural Gas Pipeline Company of America, Chicago, Illinois	350	20-26	Fritch, Texas to Wise County, Texas, through Southwest Oklahoma
	398	36	Beatrice, Nebraska to Joliet, Illinois.
	91	30	Loops in Nebraska, Kansas, Oklahoma.
Nevada Natural Gas Company, Las Vegas, Nevada	114	10	Loop of present system
New York State Natural Gas Corporation, Pittsburgh, Pennsylvania	27	—	Extend existing line from Elk County, Pennsylvania to new gas field in Clearfield, Jefferson, and Indiana Counties, Pennsylvania.
Northern Natural Gas Company, Omaha, Nebraska	15	24	Loops on system in Nebraska
	28	24	Ogden to Redfield storage area, Iowa
	168	20	St. Paul-Minneapolis to Duluth, Minnesota and Superior, Wisconsin
	163	10-12	Main lines in South Dakota
	307	Var.	Branch lines in South Dakota, Minnesota, Iowa, and Wisconsin
	100	20-24	Savanna Creek field, Alberta to Alberta-Montana border near Cardston, Alberta.
Northern Plains Natural Gas Co. (Subsidiary Northern Natural Gas Co.)	1100	26	Alberta-Montana border to Minneapolis, Minn.
Northwest Utilities, Ltd.	42	—	Bonnie Glen to Edmonton, Alberta
Offshore Gathering Company, Houston, Texas	364	30	Offshore gas line in Gulf of Mexico from Sabine Pass to Mississippi River
Pacific Gas & Electric, San Francisco, California	150	34	Loops on Topock, Arizona to Milpitas, California system
Permian Basin Pipeline Company, Omaha, Nebraska	19	16	Gathering system for 15 West Texas gas fields
Pioneer Natural Gas Company, Amarillo, Texas	261	3-22	New lines, loops, replacements and irrigation feeder lines in the Panhandle and South Plains of Texas
Pine Tree Natural Gas Company	204	—	Boston, Massachusetts to Bangor, Maine
Shenandoah Gas Company, Winchester, Virginia	39	3-8	Middleton, Virginia to Martinsburg, West Virginia
Southern Counties-Southern California Gas Companies, Los Angeles, California	236	30	Topock, Arizona to Newhall, California
Southern Natural Gas Company, Birmingham, Alabama	52	—	Loops on system in Alabama, Georgia, Louisiana, and Mississippi
Tennessee Gas Transmission Company, Houston, Texas	221	26-30	Loops in Ohio and Kentucky
	100	—	New gathering lines in Texas and Louisiana
	162	—	Loops in Kentucky, Ohio, and Pennsylvania
Texas Eastern Transmission Corporation, Shreveport, Louisiana	422	30	McAllen to Vidor, Texas
	530	30	Loops on system from Texas to New Jersey
	180	Var.	Supply, lateral, and gathering lines
Trans Canada Pipe Lines, Ltd., Calgary, Alberta	2247	14-24	Alberta area to Toronto, Montreal, and other eastern Canadian areas
Trans-Carolina Pipeline Corporation, Raleigh, North Carolina	840	Var.	New pipe line system to serve 40 communities in North and South Carolina.
Transcontinental Gas Pipe Line Corporation, Houston, Texas	12.3	—	Gathering lines in Live Oak field, Vermilion Parish, Louisiana
	160	36	Additional construction planned for 1956 in Alabama,
	68	30	Georgia, South Carolina, North Carolina, Mississippi, Virginia, Maryland and Pennsylvania
Union Gas Company of Canada, Chatham, Ontario	180	—	Dawn Storage Field to Hamilton, Ontario
United Natural Gas Company	50	12	Elk County to Jefferson County, Pennsylvania
Utah Natural Gas Company, Salt Lake City, Utah	40	16	Orem to Salt Lake City, Utah
Virginia Natural Gas Company	153	—	Buckingham to Richmond and Portsmouth, Virginia



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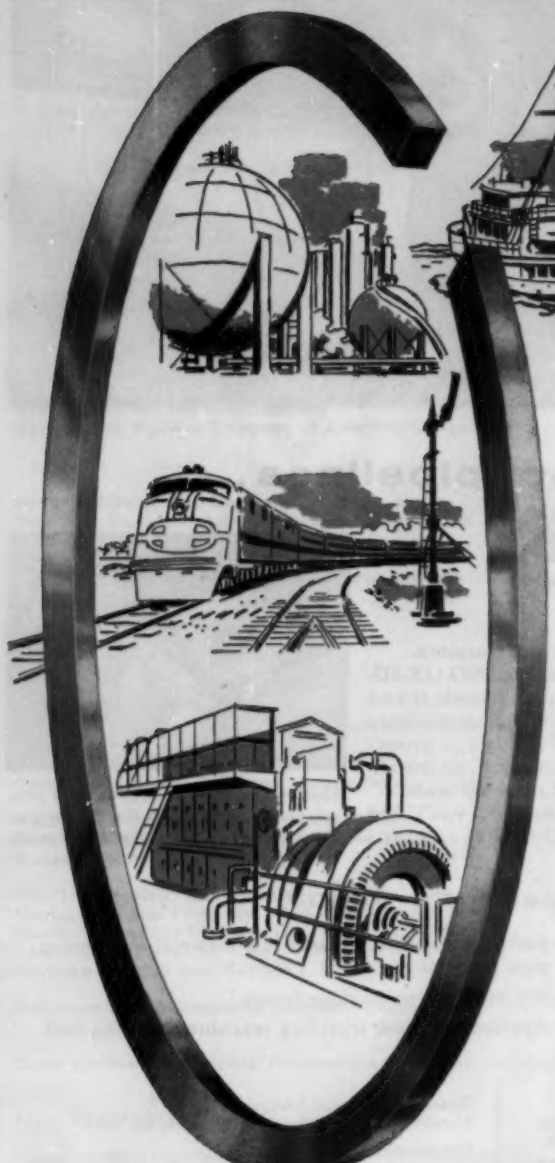
Company.....

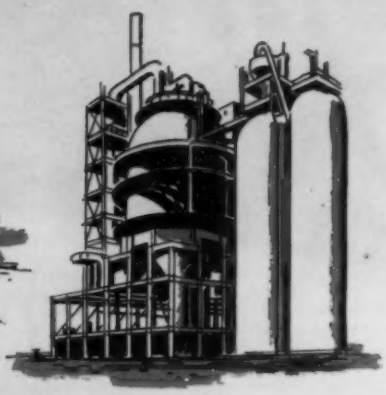
Address.....

City.....*Zone*.....*State*.....

American Hammered Piston Rings . . .

field-tested money savers!





Why not specify piston rings that have *proved* themselves? Koppers rings have been saving money and cutting costs for years—throughout the oil and gas industry, the marine industry, on major railroads, all over the chemical field, throughout the aircraft business, in municipal and industrial power plants everywhere—wherever you find gas, Diesel or steam engines, pumps, compressors, forging hammers—*wherever piston rings are needed!*

They're built to take it . . . designed to cut downtime and maintain high compression . . . give longer, more satisfactory service . . . save you money on fuel and lubricating oil . . . *and that's exactly what they do.* And Koppers rings are available in all types, all sizes—from ½" to 10′ diameter—specifically designed for the job they will do in the field where they will be used.

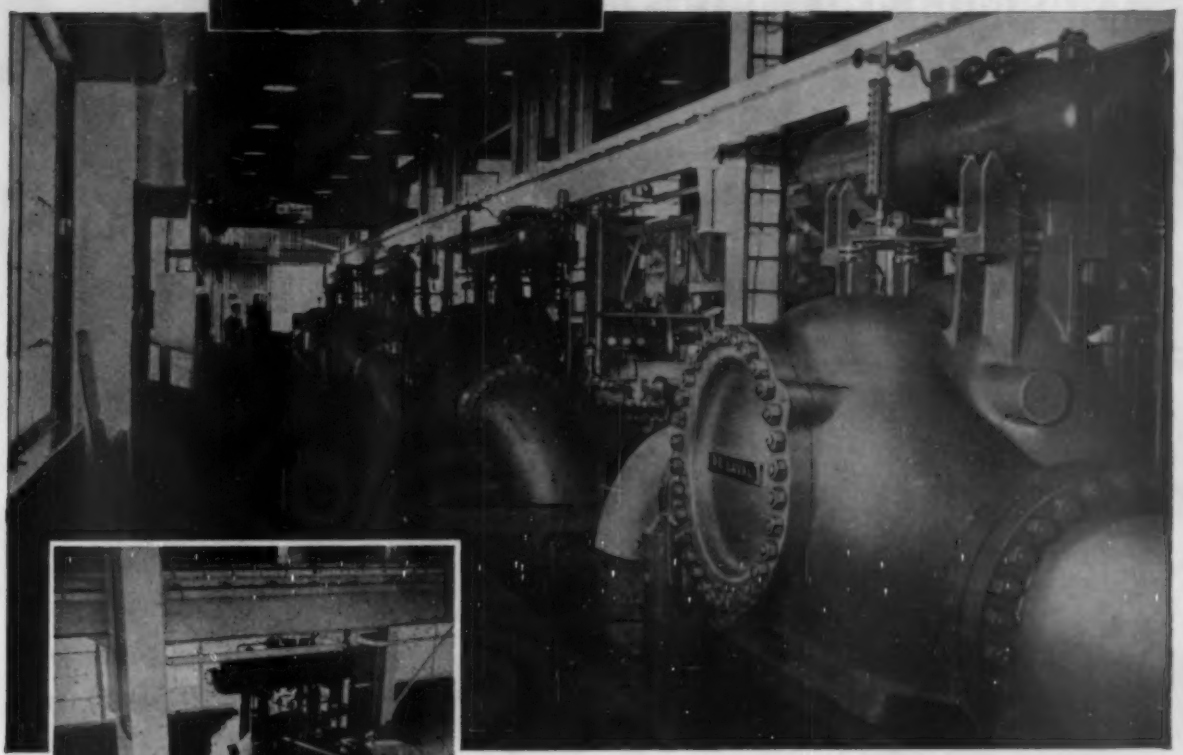
Always specify American Hammered Piston Rings. Benefit from over 100 years of experience in metal products. Use Koppers' complete engineering and metallurgical staff. Get skilled analysis of your specific problem, and prompt assistance. For 16 page Piston Ring booklet write to: KOPPERS COMPANY, INC., *Piston Ring & Seal Dept.,* 1705 Hamburg Street, Baltimore 3, Maryland.

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE 3, MD. This Koppers Division also supplies industry with Feat's Couplings, Industrial Gas Cleaning Apparatus, Aeromaster Fans, Gas Apparatus.
Engineered Products Sold with Service

KOPPERS

AMERICAN HAMMERED
Industrial Piston Rings

FOUR **DE LAVAL CENTRIFUGAL COMPRESSORS** *in Tescott, Kansas station of Northern Natural Gas*



For easy installation, De Laval pipeline compressors are designed in two packages: (1) The machine plus the emergency seal tank, (2) The auxiliary console which contains the filters, pumps, coolers and other accessories.

Here's more proof of the efficiency and dependability of De Laval centrifugal compressors for high pressure gas transmission. This Tescott, Kansas station of the Northern Natural Gas Co. has four De Laval centrifugal compressors in series.

The station flow is 930 M²SCFD, station inlet pressure 477 psig and discharge pressure 745 psig. *By changing the impeller and a few minor parts, these units can handle 1,100 to 1,200 M²SCFD.* Three identical De Laval compressors are on the job in the Macksville, Kansas station of Northern Natural.

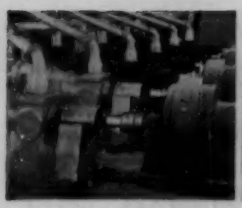
De Laval centrifugal compressors offer important engineering features. • Pressure contact shaft seal eliminates gas leakage. • Construction is heavy and rigid throughout. • Units have high load carrying capacity. De Laval units, totaling more than 280,000 hp, are now in operation on major pipelines.

DE LAVAL *Centrifugal Compressors*

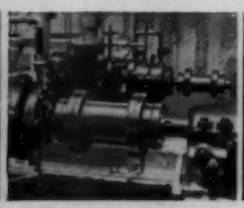
DE LAVAL STEAM TURBINE COMPANY

869 Nottingham Way, Trenton 2, New Jersey

DL-900J

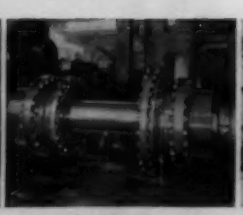


Paper Industry



Oil and Gas Industry

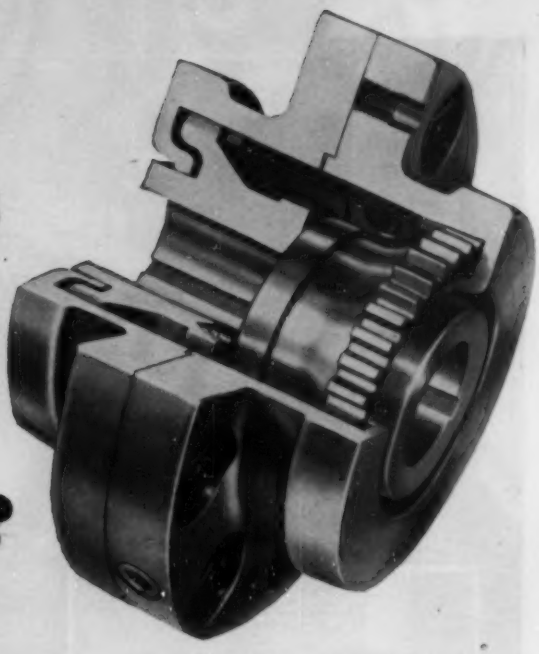
Marine Industry



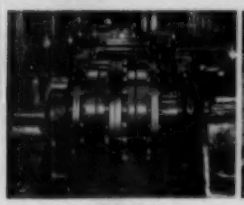
Steel Industry

Oil and Gas Industry

Why have Fast's Couplings always been the leader in the rugged oil and gas industry?



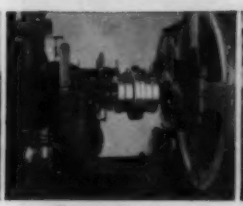
Why are they used so widely to couple machinery in Power Generation, Pulp and Paper, Oil and Gas, Marine Propulsion and Auxiliaries, Steel and industry in general?



Steel Industry

Power Industry

Lumber Industry



Chemical Industry

Paper Industry

Fast's Couplings are standard equipment with more machinery manufacturers than any shaft coupling on the American market. Many Fast's Couplings in use over 30 years still show no signs of wear when disassembled! That's the answer: they're reliable, they're *mechanically* flexible, they don't wear. They have no parts subject to repeated bending, tension or compression. There is no metal-to-metal contact, because of *positive lubrication.* Regardless of your field—no matter whether your connected machine is driven by steam turbine or electric motor, low-speed diesel or high-speed gas turbine . . . Koppers has the perfect, low-cost solution to your shaft coupling problem.

For free catalog write to: KOPPERS COMPANY, INC., *Fast's Coupling Dept.,* 3205 Scott St., Baltimore 3, Md.

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE 3, MD. This Koppers Division also supplies industry with American Hammered Industrial Piston and Sealing Rings, Aeromaster Fans, Industrial Gas Cleaning Apparatus, Gas Apparatus.

Engineered Products Sold with Service

KOPPERS

THE ORIGINAL *FAST'S Couplings*

23 NORDBERG ENGINES

power Crude and Products Pipe Lines of SALT LAKE PIPE LINE COMPANY

• A good example of how tough a job it is to get crude oil from the field to the refinery is the 182 mile "high country" pipeline operated by Salt Lake Pipe Line Company in the western mountain area.

Starting in the Rangely, Colorado field at an elevation of 5175 feet, the crude oil begins its mountain-climbing trip crossing rocky plains, steep gullies and ravines, streams and rivers and then scales a summit of 9560 feet before gravity takes over the final 45-mile leg to the refinery at Salt Lake City.

Eighteen Nordberg engines capably handle the rugged power needs for the stations on this crude oil line . . . twelve pumping units rated 442 hp at altitude, and six 75 kw D.C. generating units.

An additional five Nordberg engines are installed at the refinery for pumping refined products to market areas farther west . . . in all, a total of 23 Nordberg engines! While the majority of these engines operate on Rangely crude, the engines installed at the Rangely station are of the Duafuel® type to take advantage of the gas locally available.

This is but one example of the reliability of Nordberg power for pipeline operations. Write for further details.

NORDBERG MFG. CO., Milwaukee, Wisconsin

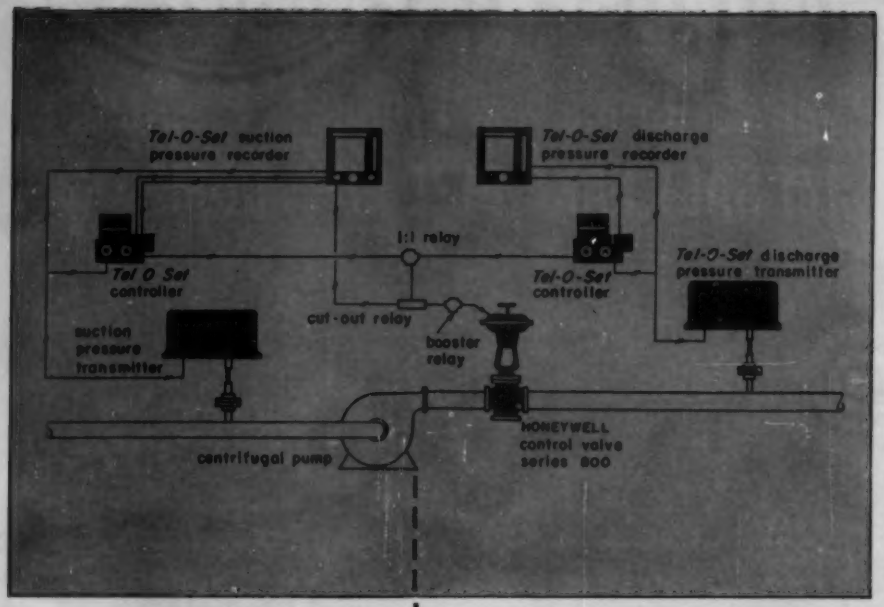
Two of three Nordberg 6-cylinder supercharged Diesels driving pumps on the No. 1 products line at the Salt Lake City Refinery.

NORDBERG

DIESEL • DUAFUEL® AND SPARK-IGNITION GAS ENGINES

O156

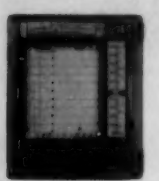
© 1956, Nordberg Mfg. Co.



Typical *Tel-O-Set* instrumentation for a centrifugal pump uses a combination of transmitter, recorder and controller for both suction and discharge pressure. Systems are interlocked through a relay to operate a Honeywell Series 800 control valve.

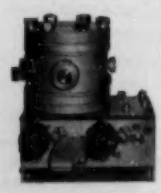
***Tel-O-Set* transmitter**

sends air signal to recorder. It's fast, accurate, compensated for changes in ambient temperature and pressure. Zero and span readily adjustable.



***Tel-O-Set* recorder**

is accurate, sensitive, compact. All adjustments made from front of panel. Complete chassis is replaceable . . . no loss of control. 30-day chart record.



***Tel-O-Set* controller**

has fast response, is unaffected by vibration. Disconnects at turn of a single switch. Each sub-assembly is a precalibrated unit, interchangeable in seconds.

FULL-TIME CONTROL

...For Pipeline Pumping Stations

Put a *Tel-O-Set* control system to work on your pumps—and you're sure of uninterrupted service. When instrument maintenance is needed, the job gets done in seconds.

The reason: transmitter, recorder and controller are designed with quickly interchangeable unit sections. You just put in a new, precalibrated unit when needed.

In performance, too, *Tel-O-Set* miniature instrumentation leads in every respect. It's accurate, sensitive, rugged. It's exceptionally easy to tune for peak operation.

Find out from your local Honeywell sales engineer how *Tel-O-Set* instruments can be applied to your station. Call him today . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa. —in Canada, Toronto 17, Ontario.

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

The most compact, reliable sampler ever built...

THE NEW Gilbarco

Small in size...
light in weight

AUTOMATIC SAMPLER

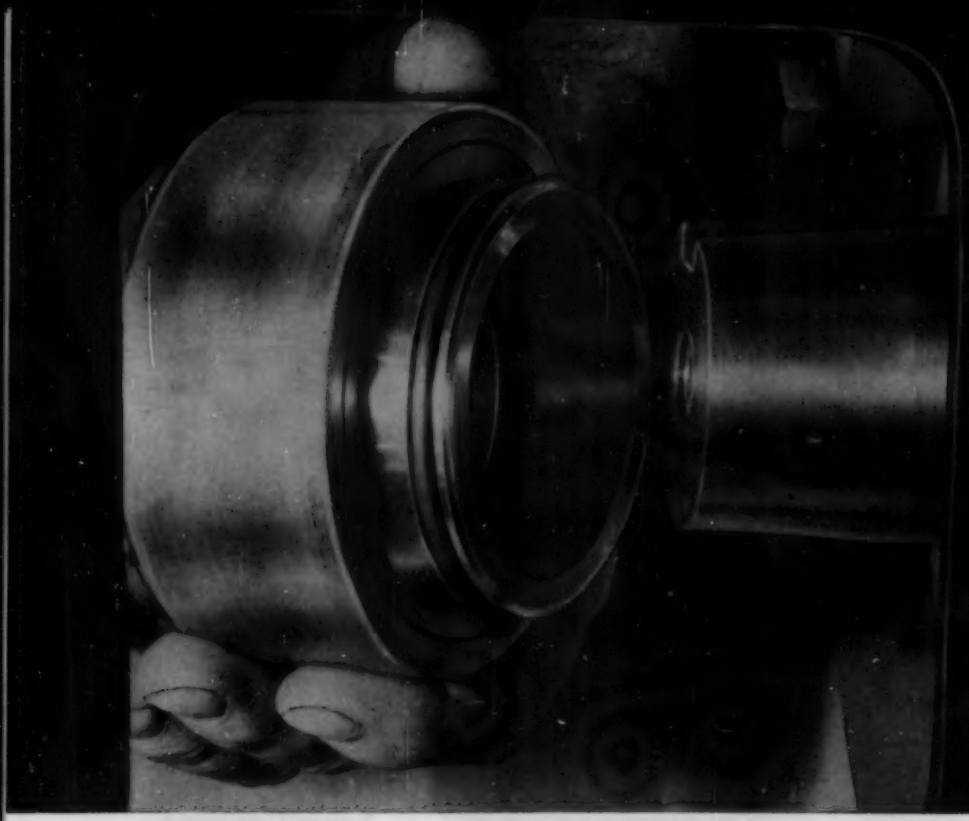
Here's a new compact, completely automatic, magnetically powered and electronically controlled sampler designed to provide a continuous sample from process or pipe lines.

USERS GET ALL THESE IMPORTANT ADVANTAGES.

- ★ Proportional to time or flow
- ★ Settings for 20 to 300 cycles per minute for more accurate sampling
- ★ No packing glands, no leakage
- ★ No electric motor, no mechanical switches
- ★ Simple to install and service
- ★ LOW initial cost . . . LOW maintenance cost
- ★ Completely explosion-proof . . . no pressure relief valves required
- ★ No hold-up time from pipe line to sample receiver; because a portion of the stream is by-passed through the sampler

Before you buy any other sampling unit, write for full details on this New Automatic Sampler.

GILBERT & BARKER MFG. CO. • WEST SPRINGFIELD, MASS. • TORONTO, CANADA



CARTRIDGE SEAL slides off mixer shaft, which uncouples to permit removal. New cartridge goes in its place. Taper on shaft insures correct alignment when recoupling.

Cut mixer maintenance 60%

with this cartridge-type *rotary seal*

Stops leakage! Runs years without adjusting! Slides off for fast, easy replacement!

If you're mixing or blending in big tanks, here's the newest way to slash mechanical mixer upkeep as much as 60%.

For here at last is a rotary mechanical seal—optional on new LIGHTNIN Side Entering Mixers—that stops leakage around the tank, ends stuffing-box repacking and adjusting for good.

And for the first time ever on big-tank mixers, you can replace this seal in a jiffy if you ever have to! No need to dismantle or remove the mixer from the tank. No need to drain the tank. No special skill required!

Even under a full head of liquid in the tank, the seal-change job is so simple it takes only minutes. The mixer shaft retracts to seal the tank, then uncouples. The seal cartridge slides off in one piece. A new cartridge slides on; the mixer shaft automatically realigns itself when recoupled—and you're back in operation.

The LIGHTNIN seal cartridge is a complete unit assembly, easy to stock as a replacement, or quickly obtainable in all sizes and materials, for the simplest or most difficult operating conditions.

Already, many oil companies are using LIGHTNIN Seals—and saving many thousands of dollars per year. Your LIGHTNIN Mixer representative can give you the full story—show you how much *you* can save. Call him today—he's listed in your copy of Refinery Catalog. Or get the facts by mail: send the coupon for 8-page, fully illustrated bulletin.

"Lightnin' Mixers"
MIXCO fluid mixing specialists

Left: **NO STUFFING BOX** to repack or adjust. No leakage around the tank. When correctly applied, seal runs for years without adjustment. *Right:* **REPLACEMENT** is simple, even with tank full. Mixer shutoff closes like a valve to keep liquid in the tank while seal is being changed.

☐ ***Quick!*** **Send us the cost-cutting facts on LIGHTNIN Rotary Mechanical Seals—Bulletin B-111. We'd also like catalog information on these LIGHTNIN Mixers:**

- ☐ B-102 Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP
- ☐ B-103 Top entering propeller types: ¼ to 3 HP
- ☐ B-104 Side entering: 1 to 75 HP
- ☐ B-108 Portable: ⅛ to 3 HP
- ☐ B-112 Laboratory and small-batch production types
- ☐ B-110 Condensed catalog showing all types
- ☐ B-107 Data sheet for figuring mixer requirements

Check, clip, and mail with your name, title, company address to:

MIXING EQUIPMENT CO., Inc., 127-e Mt. Read Blvd., Rochester 11, N.Y.

In Canada: Greey Mixing Equipment, Ltd., Toronto 10, Ont.

Enough to run a pipe line from San Francisco to London

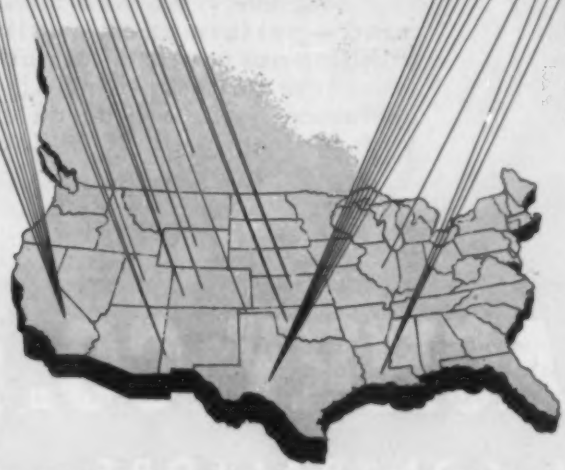
THE gas and petroleum transmission industries can take great pride in the gigantic jobs they've completed in recent years.

As a major supplier of large diameter steel line pipe, Kaiser Steel has been privileged to play an important part in these vast undertakings. In five years, enough line pipe of various diameters has been shipped from our Napa, California plant to run a pipe line from San Francisco to London.

Shown below is a partial list of major customers, who have used Kaiser Steel Line Pipe in scattered locations from New York to California, from Canada to Mexico.

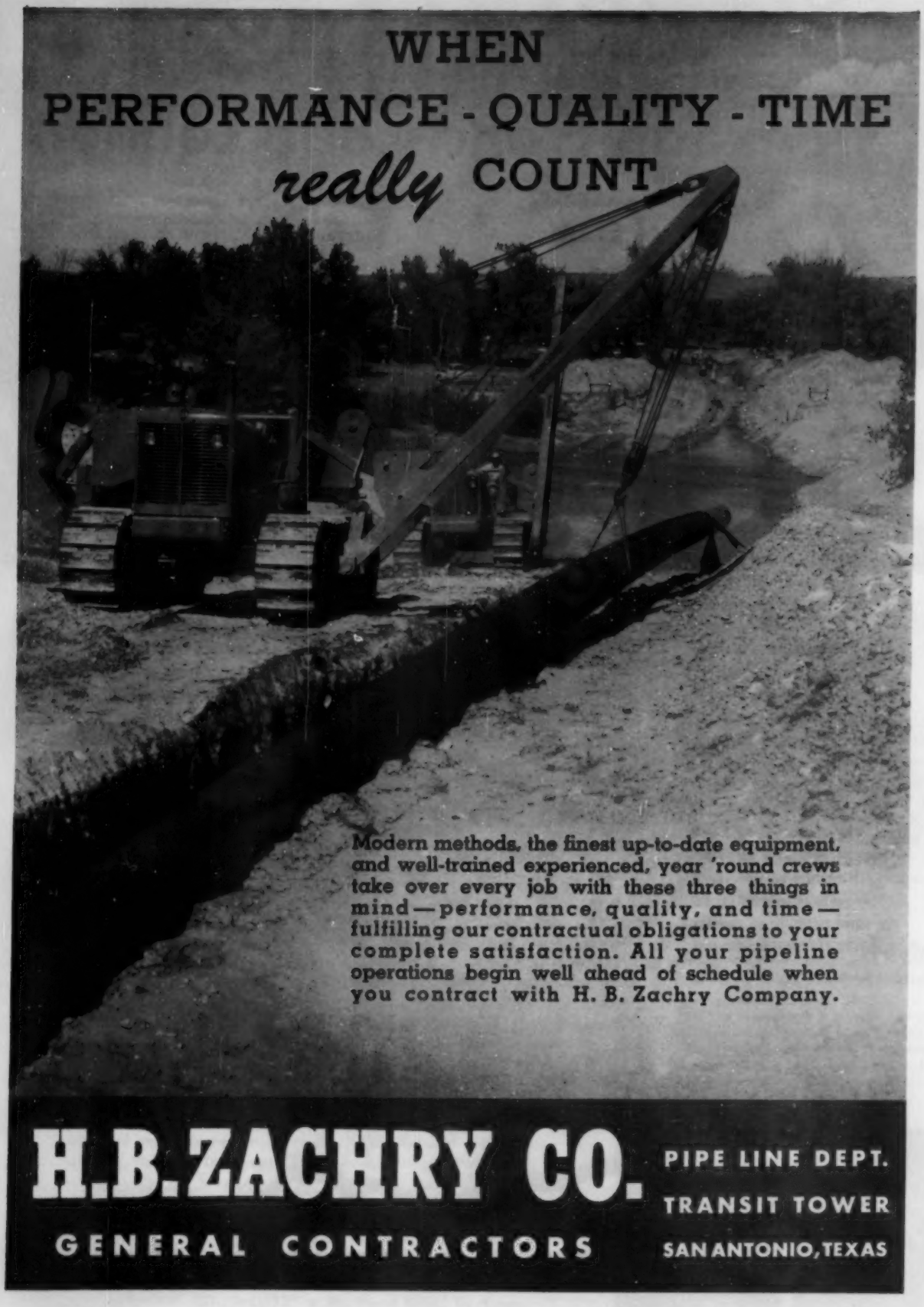
CITIES SERVICE GAS CO.
NORTHERN NATURAL GAS COMPANY
PANHANDLE EASTERN PIPE LINE CO.
SINCLAIR PIPE LINE CO.
INTERPROVINCIAL PIPE LINE CO.
OKLAHOMA NATURAL GAS CO.
PLATTE PIPE LINE CO.
NATURAL GAS PRODUCERS, INC.
THE MONTANA POWER COMPANY
COLORADO INTERSTATE GAS CO.
ARAPAHOE PIPE LINE CO.
TRANS MOUNTAIN OIL PIPE LINE CO.
MOUNTAIN FUEL SUPPLY CO.
SOUTHERN UNION GAS CO.
EL PASO NATURAL GAS CO.
PACIFIC GAS & ELECTRIC CO.
STANDARD OIL COMPANY OF CALIFORNIA
UNION OIL COMPANY OF CALIFORNIA
RICHFIELD OIL CORPORATION
SOUTHERN COUNTIES GAS CO.
TIDE WATER ASSOCIATED OIL COMPANY
SOUTHERN CALIFORNIA GAS COMPANY

Kaiser Steel

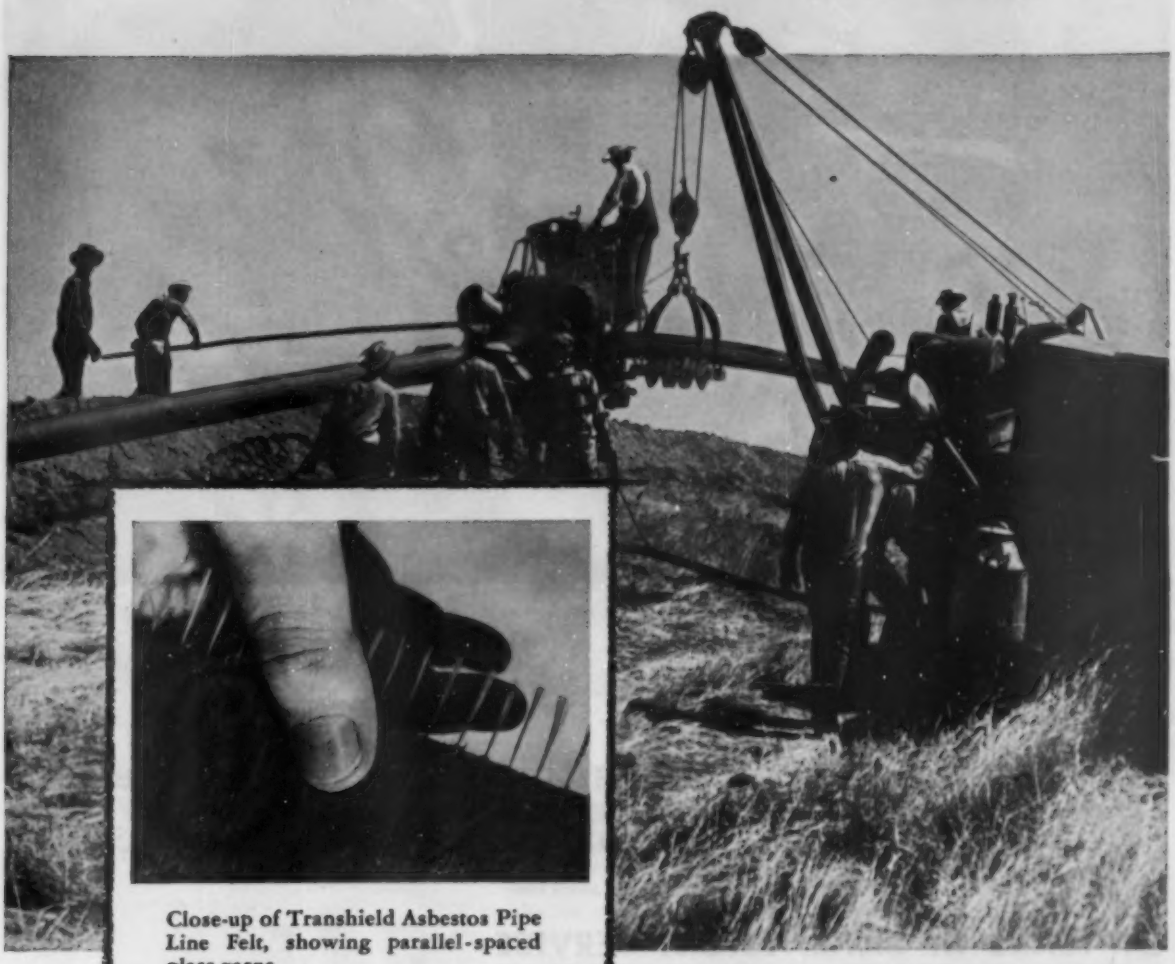


GULF OIL CORPORATION
GULF REFINING COMPANY
PHILLIPS PETROLEUM CO.
PHILLIPS PIPE LINE CO.
TENNESSEE GAS TRANSMISSION CO.
THE TEXAS PIPE LINE COMPANY
PIONEER NATURAL GAS COMPANY
TRUNKLINE GAS COMPANY
TRANSCONTINENTAL GAS PIPE LINE CORP.
TEXAS EASTERN TRANSMISSION CORP.
UNITED GAS PIPE LINE COMPANY
ASIATIC PETROLEUM CORPORATION
THE PURE OIL COMPANY
SINCLAIR OIL CORPORATION
SHELL PIPE LINE CORPORATION

Steel Mill Products: plates • hot rolled strip and sheet • cold rolled strip and sheet • tin plate • continuous weld pipe • electric weld pipe • alloy and carbon bars • bar shapes • structural shapes semi-finished steels • pig iron • ingot molds • coke by-products • **Fabricating Division:** steel fabrication for construction, aircraft, missile and other industries • expanded fusion weld pipe reinforced concrete pipe • tanks • For specifications, write: **KAISER STEEL CORPORATION** • Los Angeles • Oakland • Seattle • Portland • Phoenix • Denver • Tulsa • New York


WHEN
PERFORMANCE - QUALITY - TIME
really COUNT
Modern methods, the finest up-to-date equipment, and well-trained experienced, year 'round crews take over every job with these three things in mind — performance, quality, and time — fulfilling our contractual obligations to your complete satisfaction. All your pipeline operations begin well ahead of schedule when you contract with H. B. Zachry Company.
H.B.ZACHRY CO.
GENERAL CONTRACTORS
PIPE LINE DEPT.
TRANSIT TOWER
SAN ANTONIO, TEXAS

For effective, long-term protection against corrosion . . .



Close-up of Transhield Asbestos Pipe Line Felt, showing parallel-spaced glass yarns.

Coating and wrapping pipe line to check corrosion and assure long-term service.

. . . use Johns-Manville TRANSHIELD® ASBESTOS PIPE LINE FELT

Johns-Manville Transhield is an economical pipe line felt assuring effective, long-term protection against corrosion under average soil conditions.

Designed for easy, high-speed application by modern machine methods, Transhield is strong and highly tear-resistant. Its light weight permits its use in 800-ft. rolls. This advantage cuts roll changes in half for field wrapping equipment.

Transhield provides a protective membrane of coal-tar saturated asbestos felt, reinforced with continuous glass yarns parallel-spaced on ¼" centers. It cannot rot or decay, thus acts as an enduring barrier to shield pipe line enamels from earth loads and soil stress.

For severe soil conditions use Johns-Manville #15 Asbestos Pipe Line felt . . . proven in service for over 30 years.

For further information about Transhield, write to Johns-Manville, Box 60, New York 16, N. Y. In Canada, 565 Lakeshore Road East, Port Credit, Ont.

Johns-Manville PRODUCTS FOR PIPE LINE PROTECTION

The dispatcher receives hourly reports on pressure, temperature, gravity, and rate-of-flow from each station on three pipe lines.

SOCONY MOBIL OIL COMPANY, INC., REPORTS:

One dispatcher controls three eastern pipe lines with Bell System private line telephone service

24 YEARS OF SATISFACTORY SERVICE

One dispatcher—in Plainfield, N. J. —controls 1077 miles of Socony Mobil pipe line in seven states, as shown on the map above.

He uses Bell System private line telephone service to get hourly reports on pressure, temperature, gravity, rate-of-flow and other operating information from as many as 60 points along the system.

Over the same facilities, he issues orders to cut in additional pumps or cut them off, run gasoline and distillates into tanks, or put products into the line from refineries.

Socony Mobil started using Bell System private line communications 24 years ago, and the company's growth has been accompanied by a corresponding growth in its communication system.

The Bell System can supply services to fit *your* exact communication needs, too. Just call your Bell Telephone representative for further information.

Socony Mobil uses these Bell System private line services:

Private line telephone service for pipe line dispatching and general administration.

Private line teletypewriter service for fast written communication between New York headquarters and the Paulsboro, N. J., refinery.

BELL TELEPHONE SYSTEM

TELEPHONE . TELETYPEWRITER TELEMETERING AND REMOTE CONTROL CHANNELS

YOU GET MORE FOR YOUR MONEY

WORLD'S LARGEST DITCHER, the model 330, is another Gar Wood-Buckeye first! It digs 600 cubic yards per hour, cuts a ditch 11 feet, 3 inches deep and 64 inches wide. Yet, it is easily operated by one man. The 330 is typical of the years-ahead engineering that pipeliners have come to expect from Gar Wood-Buckeye.

WORLD'S MOST MODERN DITCHER, the Buckeye 308, reflects many of the engineering advances of the giant 330. Exclusive live hydraulic wheel hoist gives you faster, more accurate positioning of digging wheel . . . exclusive hydraulic conveyor drive provides three discharge speeds in either direction, adjusts instantly to handle any volume of spoil.

. . . in ditchers that bear the Buckeye brand!

Over the years, Buckeye ditchers have led the field in engineering advances. The world's first ditching machine, the first wheel-type ditcher, the first ladder-type ditcher . . . all have been Gar Wood-Buckeye developments. No wonder pipeliners who know equipment value have come to expect more for their money in ditchers that bear the Buckeye brand.

And — today's advanced Gar Wood-Buckeye machines are better than ever! Operation is faster, easier . . . operator control is positive and accurate . . . adjustments for changing digging conditions can be made in much less time. Maintenance is easier, too. There are more anti-friction and sealed-for-life bearings . . . many design improvements that make for faster field servicing.

In terms of ditch per dollar, in terms of day-in, day-out dependability, Gar Wood-Buckeye ditchers still lead the field. Ask your Gar Wood-Buckeye dealer to show you what modern ditcher performance can be. Or, write direct to: Customer Service Department, Gar Wood Industries, Inc., Wayne, Michigan.

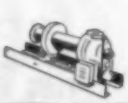
GAR WOOD INDUSTRIES, INC.

Wayne, Michigan • Findlay, Ohio

Plants in Wayne and Ypsilanti, Mich., Findlay, Ohio; Mattoon, Ill.; Richmond, Calif.

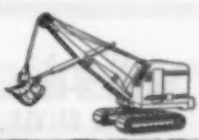
Gar Wood Buckeye

Gar Wood-St. Paul Hoists & Bodies



Gar Wood Winches

Gar Wood Tractor Equipment



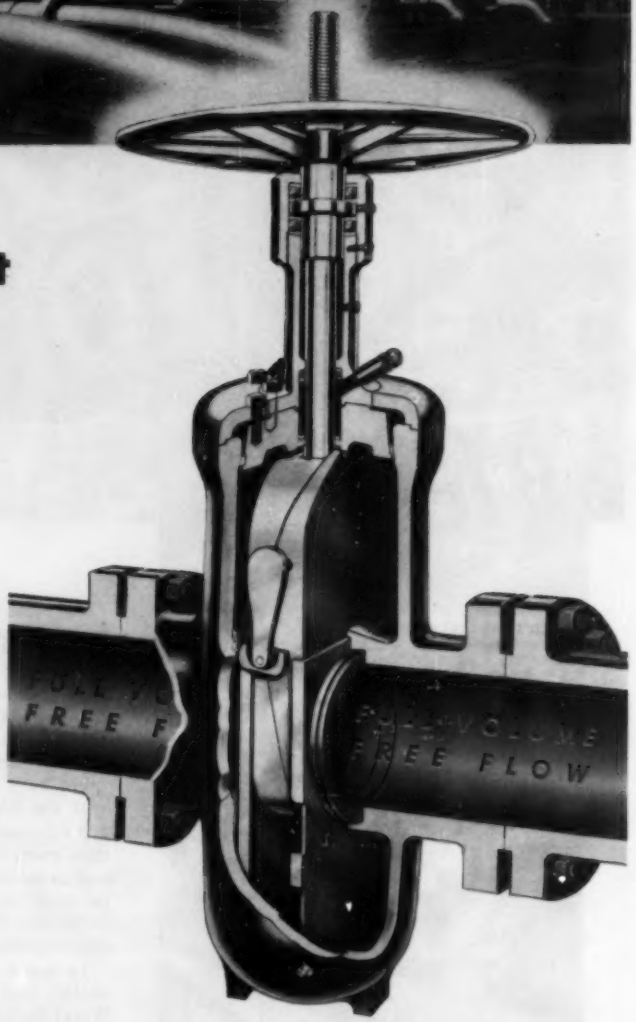
Gar Wood Excavators

W-K-M Through-Conduit VALVES

Main lines with W-K-M Valves all the way are the "expressways" of pipeline transportation. The smooth bore through a W-K-M Valve is the same as the I.D. of the pipe and permits the same full volume, free flow as the pipe itself, and allows no more pressure drop or turbulence than an equivalent length of smooth wall pipe. Pump or compressor power is concentrated on transmission — not wasted overcoming obstructions. Scrapers may be run freely through the valves when cleaning the line.

Other advantages of W-K-M Pipeline Valves that contribute to their efficiency in service on the line are Leverlock Control of the parallel expanding gate; pressure seal bonnet that seals tighter as pressure increases; renewable seats; Superfinished stems, ball bearing operation for easier opening and closing under any conditions.

Write or ask your W-K-M Representative for our new pipeline catalog No. 300.



W-K-M MANUFACTURING COMPANY, INC.

A SUBSIDIARY OF acf INDUSTRIES INCORPORATED

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MANUFACTURING

W-K-M THROUGH-CONDUIT GATE VALVES

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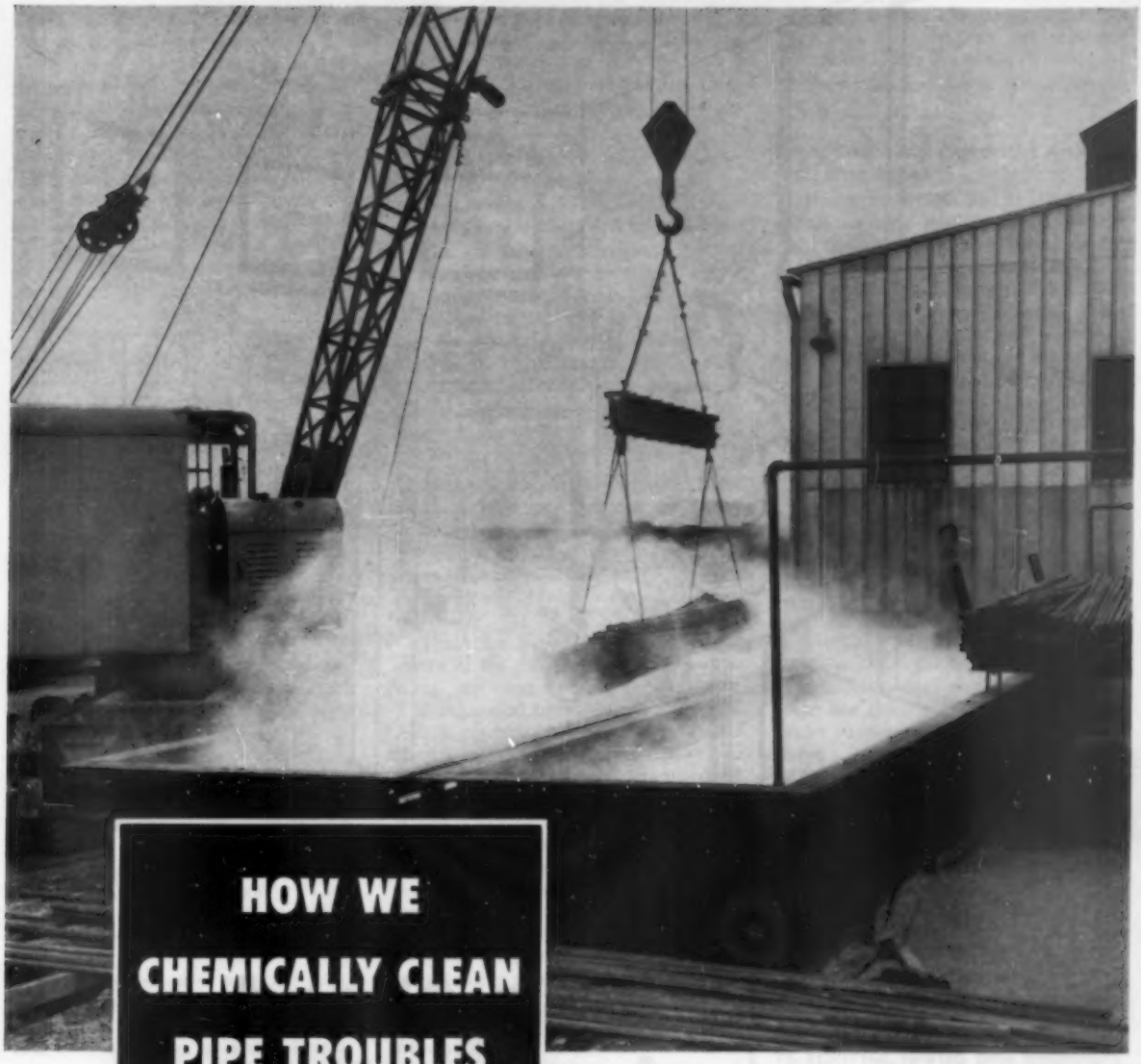

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Central Control Station of the Future? Most of the functions of pipe lines will be automatically controlled. Custody transfers on products lines, etc., will be handled automatically by computers. On gas systems the purchase and power settings at compressor stations will be actuated by a long range weather forecast receiver. This high degree of automation will probably reduce the work week to something like 26 hours. (Note the golf clubs, etc.). Calendars, however, will remain the same except for the changing dates.

P 605.

What's Ahead in Pipelining?

Donald M. Taylor
Gulf Coast Editor

As a rule, forecasters of *things to come* have tended to sell Man short. For instance, in 1844 the U. S. Commissioner of Patents gloomily prophesied that the time was not far off when further improvements would end. With the advent of the early automobile, doctors freely predicted that man's brain could not withstand the high speed of the vehicle.

Only science-fiction writers (and cartoonists) have come close to the truth in forecasting technological developments. Today, these men are hard pressed to stay ahead of the inventions and scientific advancements that spew from our research laboratories.

It seems incredible that the major U. S. industries were born less than 100 years ago! The aircraft, automotive, petroleum, radio, movie, television industries were not even conceived in 1856. And just 25 years ago, the average man wouldn't have dreamed that miracle drugs, jet engines, television, and nuclear energy were just around the corner.

Will the next 100 years bring equal

advancements? Will industries arise that today are unknown?

Chances are the answer is *yes*. Scientists say we are on the upswing of the curve of scientific progress. There are discoveries in our laboratories that are almost certain to have commercial application. For example, one research group has produced iron crystals that have a tensile strength of more than 1,000,000 psi, and there are hundreds of new plastic materials waiting in line, so to speak, for commercial development.

One of the country's leading scientists predicts that the time is not far off when we will control the world's climate to suit our needs. Solar energy is being harnessed (the sun's energy falling on the roof of the average home is 500 times the electrical energy now used inside the house). Barring an innihilation through war, the average life span will be increased immeasurably.

Population and energy consumption forecasts. One of the key factors that will influence future technical advances is population increase. Today the population of the earth is 2½ billion. Forecasters say it will be 3¼ billion by the year 2000 and 7 billion by 2050!

But of the 2½ billion inhabiting the globe today, 2 billion are hungry. Yet, even as four out of five of the earth's populace hungers, the number of U. S. farmers has been decreasing and at the same time production of food stuffs has been soaring! Today, this country's surplus food is sufficient to feed 65 million additional people — as well as we ourselves are fed.

We achieved this bountiful state through free enterprise and widespread application of mechanical energy. Where once all farm work was done by animal and muscle, now 95 per cent is done by tractor, electricity, etc.

It is only through undreamed of energy consumption that this earth will be able to supply the vast population of the future with food and shelter.

The chief economist of one of our major oil companies has predicted that world consumption of energy will double in the next 25 years and re-double in the following 20. Thus in less than 50 years, the world will use four times as much energy as it does today.

Oil and gas will continue to supply a major part of this energy in the foreseeable future. By the year 2000 scientists predict that atomic power may be supplying one-fourth of the world's energy, but the world's consumption of oil will have risen from 14,000,000 bbl a day to somewhere around 40,000,000 to 45,000,000.

A shorter range prediction says that by 1975 the U. S. will gobble petroleum at the rate of 14,000,000 bbl a day in contrast with the 8,000,000 bbl it now consumes. Over this same period, gas consumption will rise from 8 trillion cu ft per year to 20 trillion cu ft!

Where will all this oil and gas come from? A large portion must come from abroad. Today, the U. S. is using three-fifths of all the oil produced in the world, yet this country has only one-fifth of the world's proved reserves. The great offshore fields will be fully developed in the next 20 years or so, and large quantities of oil and gas will be pipelined from Canada and Mexico. Great new oil producing regions in Africa, Asia, Europe, and possibly the arctic regions will be explored and exploited.

How will the pipe line industry fare? During this vast expansion of energy reserves, the pipe line industry will prosper. *It will continue to prosper and expand so long as it provides the most economical and feasible means of transportation!*

There are many — even within the ranks of the pipe line industry — who have time and again compared pipe line expansion with railroad growth of half a century or so ago. Every year they have predicted that the next would mark the end of construction. What these prophets of gloom fail to consider is that the rails did profit and expand so long as they provided the most economical and feasible means of transportation for expanding markets. When pipe lines, airlines, buses, and trucks excelled them, the railroads faltered and lost business.

So long as pipe line markets continue to expand, and so long as pipe lines afford the cheapest and most feasible means of transportation, the industry as a whole will continue to expand and prosper.

The pipe line industry is entering fields other than gas and oil. As population increases, it will be more important than ever to bring large quantities of water, fertilizer, and soil together. In many cases the most economical way to do this will be through pipe lines. In recent years we have been constructing an increasing number of miles of steel water lines. Now that suitable internal coatings have been developed, steel water lines look for a sharp upswing in this direction.

Pipe lines to carry solids are being planned and constructed. In Ohio, a large coal company is constructing a line to carry a coal slurry from mine to power plant; a gilsonite line is planned for the west and other such lines are being considered.

How can the pipe line maintain leadership in the transportation industry of the future? The answer is through technical advancement and efficient operation. Here are a few of these advancements that seem to be in the offing:

New Technical Advances Ahead For Pipe Lines

Improved metals. In the laboratory, scientists have made crystals of iron that have a tensile strength exceeding 1,000,000 psi. They have made aluminum and magnesium crystals of 500,000 psi tensile strength or more. These fantastic strengths are made possible through control of molecular structure and through eliminating contamination. Although pipe of this great strength may be a long way off, *improved* pipe is near at hand. Vacuum furnaces that greatly minimize contamination have been developed to produce special steels and alloys. Larger furnaces of this type are on the way.

Solar furnaces will enter this field too. Already we have such furnaces that will produce 7000 F!

Plastic pipe. Exciting advances are being made in the field of plastics, and this material has already entered the pipe line field. There are plastic laminates in use today (not as pipe) that have a tensile strength exceeding 65,000 psi. This compares favorably with steel.

Researchers with one chemical company recently developed a new process for making one of the popular plastics, which they believe will be so cheap that the product may be used for paving roads. With proper extruding machines, it may become possible actually to make the pipe over the ditch as it is laid.

Several prominent pipeliners have predicted that reinforced plastic submarine pipe lines will be extruded from lay barges. In order to obtain adequate negative buoyancy, a continuous hollow lobe will be simultaneously extruded along the primary pipe and filled with a slurry of magnetite. Every 20 ft a capsule of Cobalt 60 will be injected into the slurry so that decisive location of the pipe can be established. With a half-life of only five years, the Cobalt capsules will be replaced by a diver firing a pellet into the self-sealing plastic lobe.

Pipe coatings. Plastics will provide the answer to almost perfect, but inexpensive, pipe coatings. A new coating on the market today may revolutionize pipe laying. It can be sprayed or painted onto the pipe just like whitewash on a fence. It can be used in combination with a glass mesh and applied at ambient temperature.

Four lines already have been coated with the new material, which is made

of epoxy resin and coal tar mixed with an amine curing agent. When the two basic chemicals polymerize, they establish cross linkages, and the resulting coating is homogenous, tough, and elastic enough to withstand the power and rough handling of the bending machine. With this coating on it, a line can be constructed as though it were of bare pipe.

Pipe line construction. Sonic vibration will undoubtedly be applied to pipe line construction in a number of ways. This form of energy transfer is in use today in metal cleaning and has made its appearance in oilfield pumping. One of the U. S.'s big research institutions is trying to perfect a commercial application of a sonic oil well drilling rig.

Some vibration should have an application in pipe line ditching, backfilling and the drilling of road crossing.

Pipe line river crossings. In the distant future, failures of pipe line river crossings will almost never occur. Most failures occur when the river scours beneath the pipe, and the current sets up harmonic vibration, which causes the pipe to fail in fatigue. Perhaps, light metal triangular vanes on the downstream side of the pipe will be able to break up the periods of the vibrating span. This method has worked on aerial pipe spans where wind eddies caused the pipe to undulate.

Automation. The pipe line of the future will be fully automatic in all its functioning, beginning at the source of production and terminating at the ultimate delivery point. This includes unattended, automatic lease operation, incorporating the custody transfer of either gas, liquid, or solid bulk volumes, in which overriding controllers accurately balance the rate of producing or recovering operations to conform with predetermined and preset optimum values.

Instead of following current practices of measuring, buying, and selling hydrocarbons and other bulk commodities by cubic feet, pounds, barrels, or gallons, (typical bulk measuring yardsticks of today) a continuous mass spectrometer will be used to analyze components and a continuous totalizer will tally molecular units. Disagreements concerning heating values, pressures, orifice coefficients, densities, and temperatures will be eliminated, for molecular composition is the fundamental measure of the value of the product being bartered.

Data from the totalizer, properly codified, will be fed to central digital computing equipment, which will issue credits and debits to the participating parties.

Closed TV circuits and safety devices. The remote operator of the future pipe line system will employ closed channel TV circuits for local station supervision. Telemetering will transmit detailed information to the remote operating point where it will be accurately and swiftly assayed by computing equipment. A TV camera mounted on a selsyn motor will provide continuous scanning of pump station conditions.

Safety devices sensitive to temperature and light will judiciously energize firefighting equipment and report trespassing inside the station by animal or man.

Automatic deliveries to small terminals and service stations near products lines. More and more deliveries to small terminals and service stations along the route of products lines will be made in the future. It is uneconomic to haul products past a town and then haul them back via truck or tank car from the terminal. Small remote valve and meter stations will be developed to enable the automatic dispatcher to make these small cuts from various tenders as needed.

Cybernetics. As applied to the pipe line industry, this refers to the combination of analytical calculators with instruments via wire line or radio. One of the major gas transmission companies has already embarked on a program along this line. The company uses digital computers to make daily totals of purchases and sales and to keep track of stores and supplies. The company is now testing equipment to automatically remember totals from meters, etc., and to send them to a home office receiver, which in turn will store the various facts on memory drums or tapes until needed. At the end of each day, total purchases and sales will be calculated. At the end of the month, the financial balance will be calculated and printed, and even the payment checks to the gas producers and royalty owners will be machine printed.

Within a year or so company engineers hope to tie remote meters that read directly in mcf into the system. These meters have already been developed, calculating volumes from orifice differential, temperature, pressure, and specific gravity.

But back to **cybernetics.** If the company adds another calculator that can figure engine power settings, rpm's, etc., weather forecasts can be fed into the machine as a control index, and the entire gas system will be automatically dispatched — all the way from the purchase meters to the sales meters.

Cathodic protection. Solar energy units already used to power telephone circuits can easily be adapted to rectifier units in remote locations along the line.

Pump station and compressor engines. In the immediate future we will have engines of 50 per cent efficiency or better. Later on, perhaps we will have engines with 90 or so per cent efficiency.

One of the leading engine manufacturers has been experimenting with a version of the free piston engine for several years. Unofficial reports say that the engines are developing efficiencies in the region of 50 per cent. This engine is in reality an offshoot of the gas-fired turbine in that it generates hot pressured gases, which are expanded across a gas turbine.

Other versions of the gas turbine are being designed. One group is experimenting with a recriprocating engine that drives an axial flow compressor to supercharge itself and then expands the hot exhaust gases across a gas turbine. Still another version is the fire wheel, which has a combustion chamber built along the lines of a twir to gain slight compressing during the burning of the gases.

Because the gas-fired turbine is so closely related to aircraft power units it is safe to predict that there will be many improvements forthcoming in the next few years.

The day will undoubtedly come when oil and gas will **not** be used for heating, but instead, be conserved because of the chemical values. Automobiles and helicopters will be run by atomic energy or solar energy in electrical form. But when this time comes, pipe lines probably will have so many uses, other than for transportation of petroleum products, that this market will hardly be missed.

Who knows but what the predictions of one science-fiction writer may come true. He predicted pipe line subways would provide almost instantaneous travel from coast to coast. The inside of the pipe would be evacuated and the cars inside suspended magnetically — not touching the sides. The car would be magnetically powered by coils on the outside of the pipe — providing a frictionless means of conveyance — with speed attaining thousands of miles per hour.

Then there was another science-fiction writer who thought . . .

Acknowledgment: Some of these ideas came from a panel discussion presented before the Pipeliner's Club of Houston in February. The panel members included W. H. Bruyere, chief engineer American Oil Pipe Line Co., Bob Ledford, general manager Marine Gathering Co., and Don Taylor, **The Petroleum Engineer.** ★ ★ ★

EXCLUSIVE

Part 1

How to Work the Revised Panhandle Formula

If you can add, multiply, and divide you can calculate gas flow

John F. Schomaker
L. E. Hanna

A NUMBER of equations has been used to predict the rate of flow of gas in a pipe line. Most of these are inadequate, however, to handle the high pressure and the large diameter lines now in use. The expressions presented here are modifications of that formula previously known as the Panhandle Formula. They are specifically designed for use with high pressure, large diameter pipe lines where the flow rates may vary quite widely.

In order to present a complete picture, some common background and intermediate material is included in this study. A semi-graphical solution of the new flow equation is indicated as the best method for repeated use of the expression.

Background

The basic theory behind the derivation of the general equation for the flow of gas may be found in the more complete texts on fluid flow and thermodynamics. The derivation generally starts from a very basic energy balance and proceeds to an expression similar to equation (1) as follows:

$$m^2 = \frac{gMD\,(P_1^2 - P_2^2)}{4RT_fLf}, \text{ in consistent units} \qquad \text{equation (1)}$$

m = mass flow rate,
P_1 = upstream pressure,
P_2 = downstream pressure,
D = inside diameter of pipe,
T_f = flowing gas temperature, absolute
L = length of pipe,
f = Fanning friction factor,
M = molecular weight of gas,
R = universal gas constant,
g = acceleration of gravity,

When equation (1) is expressed in terms common to the gas industry, the expression becomes:

$$Q = 38.774\frac{T_o}{P_o}\left[\frac{(P_1^2 - P_2^2)\,D^5}{GT_fL}\right]^{1/2}\left(\frac{1}{f}\right)^{1/2} \qquad \text{equation (2)}$$

Where:
Q = cubic feet per day at P_o and T_o,
T_o = base temperature F absolute,
P_o = base pressure, psia,
P_1 = upstream pressure, psia,
P_2 = downstream pressure, psia,
T_f = flowing gas temperature, F absolute,
D = inside diameter of pipe, in.,
L = length of line, miles,
G = gas gravity referred to air,
f = Fanning friction factor.

T. W. Johnson and W. B. Berwald*, in their examination of flow equations used at the time of their publication, give a very thorough derivation of the general flow equation (2).

Several important assumptions were made in reaching this point. They are as follows:

1. The flow is steady.
2. The flowing temperature is constant.
3. The kinetic energy change is negligible.
4. The fluid follows the perfect gas law.
5. There is no elevation change.

In the transmission of large volumes of natural gas, the assumption of steady flow is usually made. The assumption of isothermal conditions is also quite acceptable for the usual transmission case of a long, buried pipe line where the gas flows at substantially ground temperature and is little affected by rapid atmospheric temperature changes. For the more accurate calculations, the temperature gradient may be plotted and the graphical mean temperature used in the equation.

A kinetic energy term has been neglected in the derivation of equations (1) and (2). This omission involves the relative magnitude of the neglected term, which is $\log\left(\frac{u_2}{u_1}\right)$ compared to $\frac{2fL}{D}$, where u_1 and u_2 are upstream and downstream gas velocities and L and D are in consistent units. For the usual case of a long pipe line, the term is insignificant. For instance, with $\frac{2fL}{D}$ of 400 and $\frac{u_2}{u_1}$ of 2.0 the correction is less than 0.1 per cent. Any correction for the omission of the kinetic energy change has therefore been disregarded.

*"Flow of Natural Gas Through High Pressure Transmission Lines," U. S. Bureau of Mines Monograph 6, 1935.

The Compressibility Correction

The first three assumptions attached to the general flow equation were rather easily satisfied. The deviation from the perfect gas law, however, represents one of the principal inaccuracies of equation (2). The capacity predicted by equation (2) may be up to 10 per cent low at some transmission conditions due to the compressibility effect. A correction for the deviation in the form of a compressibility factor is now generally applied to the flow equation. The compressibility factor, Z, is defined as:

$$Z = \frac{PV}{RT}$$

Other forms of the compressibility factor (also called supercompressibility factor) are N and F_{pv} where:

$$1/Z = 1 + N = (F_{pv})^2$$

The compressibility factor Z occurs in the gas flow equation in such a manner:

$$Q = 38.774 \frac{T_o}{P_o}\left[\frac{(P_1^2 - P_2^2)\, D^5}{GT_f L Z_a}\right]^{1/2}\left(\frac{1}{f}\right)^{1/2} \quad \text{. . . . . equation (3)}$$

where Z_a is the average compressibility factor for the line pressures at the flowing temperature. It is usually sufficiently accurate to evaluate Z_a at the mean pressure, P_m.

$$P_m = 2/3\left(\frac{P_1^3 - P_2^3}{P_1^2 - P_2^2}\right)$$

The factor, Z_a, can be conveniently used as long as the equation is being solved for any of the unknowns other than P_1 or P_2. When pressure is the unknown, however, the use of Z_a becomes awkward. It is then convenient to introduce an expression for the compressibility factor in the form:

$$1/Z = 1 + JP,$$

where, for any one gas, J is a function of temperature only. As the flowing temperature is considered as a constant, the J factor poses no special problem except that it must be changed for marked variations in ground temperature. When the above expression for Z is introduced into the differential equation for gas flow and the resulting expression is solved, the following equation results.

$$Q = 38.774 \frac{T_o}{P_o}\left[\frac{P_1^2 (1 + 2/3JP_1) - P_2^2 (1 + 2/3JP_2)}{GT_f L}\right]^{1/2} (D)^{\frac{5}{2}}\left(\frac{1}{f}\right)^{1/2} \quad \text{. . . . . equation (4)}$$

Equation (4) is still not easily solved algebraically for pressure; however, the expression $P^2(1 + 2/3\,JP)$ is quite amenable to graphical solution. (See Fig. C).

The numerical value of J is a function of the gas composition and of temperature. Fig. A gives a correlation of J and reduced temperature. It is based upon the recent work of S. R. Beitler and R. H. Zimmerman.** They employ the psuedo-critical approach to compressibility of natural gas mixtures and use pure methane data as the basis for the evaluation. Their correlation for the critical properties of the mixture considers the inerts, carbon dioxide and nitrogen, and the gravity and heating value. In deriving an equation for critical temperature, they were able to eliminate one of these four variables and they chose nitrogen. The methane data used in Fig. A is from "Natural Gasoline and the Volatile Hydrocarbons."*** Fig. A is a general correlation and will handle the usual mixtures of hydrocarbon gases, carbon dioxide and nitrogen as long as the principal component is methane. If actual compressibility tests have been made on the gas in question, they should be used to determine the J term.

**Beitler, S. R. and R. H. Zimmerman, "Determination and Application of Supercompressibility Factors," 28th Southwestern Gas Measurement Short Course Proceedings, 1953.

***Brown, Katz, Oberfell and Alden, "Natural Gasoline and the Volatile Hydrocarbons," 1948.

The Elevation Effect

Equations (1) to (4) assume a level pipe line. Where the elevation at the outlet varies appreciably from that at the inlet, some correction is necessary. Even if the end elevations are the same and the intermediate elevations change markedly, some correction may be necessary. This is because the rate of pressure drop depends upon the pressure at any point, and this is influenced by the elevation of the point with respect to other points in the line. In each of the following comparisons, the length of line and inlet and outlet pressures are the same. If the outlet elevation is lower than the inlet elevation, the gas flow rate is greater than it would be for a level line. Conversely, if the outlet is higher than the inlet, the flow rate is less. If the intermediate elevations are higher than those on a straight line between the two points, the flow rate is less than that rate for a straight line between inlet and outlet. This is true regardless of whether the line is level or sloped up or down. Conversely, if the intermediate elevations are lower than those on a straight line between two points, the flow rate is greater.

J. W. Ferguson† has presented a method of handling elevation changes. He introduces a factor for a fixed rate of elevation change with distance. The general equation then becomes:

$$Q = 38.774 \frac{T_o}{P_o}\left[\frac{(P_1^2 - P_2^2 e^s) D^5 S}{(e^S - 1) GT_f L}\right]^{1/2}\left(\frac{1}{f}\right)^{1/2} \quad \text{. . . . . equation (5)}$$

Where:

$$S = \frac{0.0375\, hG}{Z_a T_f}$$

G = gas gravity,

h = change in elevation, ft,

T_f = gas temperature, F absolute,

e = base of natural logarithms = 2.7183,

Z_a = average compressibility factor.

This equation applies to a segment of line where the slope is constant. When the slope changes between two points, the equation can be applied in a step-wise manner to the individual sections where the slope is approximately constant. For this:

$$Q = 38.774 \frac{T_o}{P_o}\left[\frac{(P_1^2 - P_2^2 e^{S_t}) D^5}{GT_F L_t}\right]^{1/2}\left(\frac{1}{f}\right)^{1/2} \quad \text{. . . . . equation (6)}$$

Where:

$$L_t = \frac{L_1 (e^{S_1} - 1)}{S_1} + \frac{L_2 (e^{S_2} - 1) e^{S_1}}{S_2} + \frac{L_3 (e^{S_3} - 1) e^{S_1 + S_2}}{S_3} + \text{. . . . .}$$

$$S_t = S_1 + S_2 + S_3 + \text{. . . .}$$

The consideration of elevation changes is not quite as laborious as it first seems. If generalized values of G, T_f, and Z_a are used to determine S, then both L_t and S_t become constants for a given section of pipe line, and a simplified profile will be adequate in their determination. When both the Ferguson correction for elevation and a compressibility factor as a function of pressure are combined in the same differential

†Ferguson, J. W., Gas Age-Record and Natural Gas, July 11, 18, (1936).

equation, however, the solution of the differential equation is impractical. Thus, if the profile of the pipe line is such that an elevation correction is necessary, the average compressibility factor, Z_a, should be used in the flow equation.

The Friction Factor

It is in the selection of the friction factor, f, in equation (2) that one equation for gas flow differs basically from another. Thus, the selection of the friction factor characterizes the equation presented here.

In the turbulent region, the friction factor is a function of Reynolds number and the roughness of the pipe. At the very high Reynolds numbers encountered in the transmission of natural gas, the effect of Reynolds number on friction factor is not large. The major effect is the roughness of the pipe. It is very difficult to ascertain the degree of roughness in a pipe line other than by a test and comparison to some sort of standard for smooth pipe. Therefore, it would be very convenient to be able to express the degree of roughness for a given line as a simple multiplying factor of the quantity delivered by smooth pipe. The relation between friction factor and Reynolds number must allow a simple correction for roughness and yet remain simple enough to be easily handled in the flow equation. An empirical approach employing actual gas flow data taken to cover the range of current transmission practice is used to determine this relation. Data were gathered on large diameter pipe over a wide range of gas flow rates. The resulting expression is:

$$(1/f)^{1/2} = 16.50(R)^{0.01961}$$

where R is Reynolds number and f is the Fanning friction factor. This empirical equation represents an artificial standard for smooth pipe in the turbulent region such that a simple correction will apply for degree of roughness. The limits of Reynolds number to be observed in using the equation are 4×10^6 to 40×10^6.

The correction factor for pipe roughness will be called the "roughness factor" and designated "E." For design purposes and approximate calculations, a factor of 0.90 can be assumed for use within the limits explained above. For more exact calculations, it should be determined from a flow test for the section of line in question and will range from .80 to .95.

The Reynolds number can be expressed in terms of standard cubic feet, gravity, and pipe diameter. This requires the selection of a single value for the viscosity of natural gas. The property of viscosity changes with gas composition and also with temperature and pressure. A general value for natural gas at transmission conditions is 7.4×10^{-6} lb/ft-sec.

For this:

$$R = 1.831\frac{QG}{D}, \text{ and}$$

$$(1/f)^{1/2} = 16.70\left(\frac{QG}{D}\right)^{0.01961}$$

Although this conversion depends on a very generalized value of viscosity, it is justified because even marked changes in viscosity will have little effect on the gas flow. The correction for values other than the one assumed would be the following multiplying factor in equations (7) to (9):

$$\left(\frac{7.4 \times 10^{-6}}{u}\right)^{0.020}$$

The flow equation then becomes,

$$Q = 737\left(\frac{T_o}{P_o}\right)^{1.020} E\left[\frac{P_1^2 - P_2^2}{T_f L Z_a G^{0.961}}\right]^{0.510} (D)^{2.530}$$

. . . . . equation (7)

About the Authors

L. E. Hanna

J. F. Schomaker, was graduated from Oregon State College in 1949 with a BS degree in mechanical engineering. He attended the Illinois Institute of Gas Technology and graduated in 1951 with a degree of master of gas technology. He has worked with Panhandle Eastern since. At the present time he is serving with the U. S. Army on a military leave of absence.

L. E. Hanna was graduated from Oklahoma A & M in 1953 with a BS degree in civil engineering. After serving four years with the U. S. Army he joined Panhandle Eastern's engineering department and has advanced to the position of assistant chief engineer.

or:

$$Q = 737\left(\frac{T_o}{P_o}\right)^{1.020} E\left[\frac{P_1^2(1 + 2/3JP_1) - P_2^2(1 + 2/3JP_2)}{T_f L G^{0.961}}\right]^{0.510} (D)^{2.530}$$

. . . . . equation (8)

or, considering elevation effects:

$$Q = 737\left(\frac{P_o}{T_o}\right)^{1.020} E\left[\frac{(P_1^2 - P_2^2)\, e^{St}}{T_f L_t Z_a G^{0.961}}\right]^{0.510} (D)^{2.530}$$

. . . . . equation (9)

Equivalent Lengths of Pipe for Flow Purposes

When a pipe line is composed of several different sizes of pipe or of looped or parallel sections of line, it is convenient to reduce the line to an equivalent length of some arbitrarily selected size of pipe. From then on the line is handled as if it were a single line of the standard size and length equal to the equivalent length.

The equivalent length of a line L_E is calculated as follows:

$$L_E = \left(\frac{D_S}{D}\right)^{4.961} L$$

where D_S is the inside diameter of the standard pipe selected and D is the inside diameter of the pipe to be converted.

The equivalent length of different sizes of pipe connected in series is the sum of the individual equivalent lengths. The equivalent length of lines connected in parallel is expressed as follows:

$$L_{EP} = \left[\frac{1}{\left(\frac{1}{L_{E_1}}\right)^{0.510} + \left(\frac{1}{L_{E_2}}\right)^{0.510} + \left(\frac{1}{L_{E_3}}\right)^{0.510} + \ldots}\right]^{1.961}$$

If each of the lines in the parallel connection is of a single pipe size and of equal length, the equation can be written:

$$L_{EP} = \left[\frac{(D_S)^{2.530}}{(D_1)^{2.530} + (D_2)^{2.530} + (D_3)^{2.530} + \ldots}\right]^{1.961} L$$

For an equivalent standard pipe of 24 in. by 5/16 in., the flow equation becomes:

$$Q = 2.140 \times 10^6\, E\left(\frac{T_o}{P_o}\right)^{1.020} \left[\frac{P_1^2(1 + 2/3JP_1) - P_2^2(1 + 2/3JP_2)}{T_f L_E G^{0.961}}\right]^{0.510}$$

. . . . . equation (10)

Table 1 gives values of the equivalent length multiplier for use with equation (10).

$$L_E = F_D L$$

The Algebraic Solution

When the pipe line is composed of just one size of pipe, equations (7), (8) and (9) represent the final algebraic expressions of the flow formula. Their respective use depends, of course, upon the nature of the flow problem. Equation (7) has the compressibility correction as an average value and is not readily solved for either pressure. Equation (8) surmounts this difficulty but requires the use of Fig. C or its equivalent, prepared for the gas in question, in the solution. Equation (9) contains the elevation correction.

Equation (10) is equation (8) written for an equivalent length of 24-in. pipe. The use of equivalent lengths is preferred where the line consists of parallel pipe connections or of different sizes of pipe in series, or both. Both equations (7) and (9) can be written in equivalent form by changing the constant from 737 to 2.140×10^6 and substituting equivalent length of 24-in. by 5/16-in. pipe for actual length.

The Semi-Graphical Solution

Since equation (10) is the most general expression, it is chosen for a semi-graphical solution. Singular values for T_f, G, T_o and P_o are assumed and corrections will be made for other values of these quantities. The singular values used were:

$T_f = 520$ F absolute,
$G = 0.650$,
$T_o = 250$ F absolute,
$P_o = 14.73$ psia.

The equation then becomes:

$$Q = 4.127 \times 10^6 \, E \left[\frac{P_1^2(1 + 2/3JP_1) - P_2^2(1 + 2/3JP_2)}{L_E \cdot F_{Po} \cdot F_{To} \cdot F_{Tf} \cdot F_G} \right]^{0.510} \quad \text{equation (11)}$$

or:

$$\frac{P_1^2(1 + 2/3JP_1) - P_2^2(1 + 2/3JP_2)}{L_E \cdot F_{Po} \cdot F_{To} \cdot F_{Tf} \cdot F_G \times 10.667 \times 10^{-14}} = \left(\frac{Q}{E} \right)^{1.9608} \quad \text{equation (12)}$$

Where:

$$F_{Po} = \left(\frac{P_o}{14.73} \right)^2 \quad \text{Refer to Table 2}$$

$$F_{To} = \left(\frac{520}{T_o} \right)^2 \quad \text{Refer to Table 3}$$

$$F_{Tf} = \left(\frac{T_f}{520} \right) \quad \text{Refer to Table 4}$$

$$F_G = \left(\frac{G}{0.650} \right)^{0.961} \quad \text{Refer to Table 5}$$

Fig. B is the primary plot. It relates $\frac{Q}{E}$ to the function

$$\left[\frac{P_1^2(1 + 2/3JP_1) - P_2^2(1 + 2/3JP_2)}{L_E \cdot F_{Po} \cdot F_{To} \cdot F_{Tf} \cdot F_G} \right]^{0.510}$$

Fig C is the plot of P and $P^2(1 + 2/3JP)$.

Several examples will illustrate the use of the semi-graphical solution. The examples are designed to utilize Fig. C. For other natural gases, similar plots would be necessary although the factor J, and hence the pressure function, does not vary widely with the usual run of natural gases.

TABLES

TABLE 1. Equivalent length multiplier.

$\left(\frac{23.375}{D}\right)^{4.961}$

OD, in.	Wall, in.	ID, in.	F_D
10¾	5/16	10.125	63.47
	5/16	10.187	61.57
	1/4	10.250	59.72
12¾	5/16	12.125	25.95
	5/16	12.187	25.31
	1/4	12.250	24.66
16	5/16	15.375	7.989
	5/16	15.437	7.832
	1/4	15.500	7.674
18	5/16	17.375	4.356
	5/16	17.437	4.279
	1/4	17.500	4.204
20	5/16	19.375	2.537
	5/16	19.437	2.497
	1/4	19.500	2.457
22	5/16	21.375	1.558
	5/16	21.437	1.536
	1/4	21.500	1.514
24	5/16	23.312	1.013
	5/16	23.375	1.000
	5/16	23.437	0.9869
26	5/16	25.312	0.6737
	5/16	25.375	0.6654
	5/16	25.437	0.6574
28	3/8	27.250	0.4672
	11/32	27.312	0.4620
	5/16	27.375	0.4568
30	3/8	29.250	0.3288
	11/32	29.312	0.3253
	5/16	29.375	0.3219

TABLE 2. Base pressure multiplier.

$\left(\frac{P_o}{14.73}\right)^{2.0}$

P_o	F_{Po}	P_o	F_{Po}
14.4	0.9557	15.4	1.0930
14.525	0.9724	15.525	1.1109
14.65	0.9891	15.65	1.1288
14.73	1.0000	15.775	1.1469
14.775	1.0061	15.90	1.1651
14.90	1.0232	16.025	1.1835
15.025	1.0405	16.15	1.2021
15.15	1.0578	16.275	1.2207
15.275	1.0753	16.40	1.2396

TABLE 3. Base temperature multiplier.

$\left(\frac{520}{T_o}\right)^{2.0}$

T_o	F_{To}	T_o	F_{To}
500	1.0816	520	1.0000
505	1.0603	525	0.9810
510	1.0396	530	0.9626
515	1.0195	535	0.9447
		540	0.9273

TABLE 4. Flowing temperature multiplier.

$\frac{T_f}{520}$

T_f	F_{Tf}
500	0.9615
505	0.9712
510	0.9808
515	0.9904
520	1.0000
525	1.0096
530	1.0192
535	1.0288
540	1.0385

TABLE 5. Gravity multiplier.

$\left(\frac{G}{.650}\right)^{.961}$

G	F_G	G	F_G
0.55	0.8517	0.68	1.0443
0.56	0.8666	0.69	1.0590
0.57	0.8814	0.70	1.0738
0.58	0.8962	0.71	1.0885
0.59	0.9112	0.72	1.1033
0.60	0.9260	0.73	1.1179
0.61	0.9408	0.74	1.1327
0.62	0.9556	0.75	1.1474
0.63	0.9704	0.76	1.1621
0.64	0.9852	0.77	1.1768
0.65	1.0000	0.78	1.1915
0.66	1.0148	0.79	1.2061
0.67	1.0296	0.80	1.2208

Snow, winter temperatures, and frozen ground didn't shut down this pipeline job. Digging 16 inches wide, 2 feet deep, Parsons Trenchmobile averaged 5,000 lineal feet of trench every 9-hour shift.

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***Today* — production trenching**
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CHECK PARSONS FOR TRENCH WIDTHS FROM 8 TO 72 INCHES . . . DEPTHS TO 17 FEET

Example Problems . . .

The gas chosen is a stripped natural gas from the Texas Panhandle. It has a heating value of 1020 Btu per cu ft (gross, dry), a gravity of 0.670, and negligible carbon dioxide content. From Fig. A, the J factors were determined at three temperatures:

t_f	J
45 F	0.000184
60 F	0.000159
75 F	0.000141

With this information, Fig. C was then prepared.

No. 1

Given:

$P_1 = 900$ psia—(upstream pressure)
$P_2 = 600$ psia—(downstream pressure)
$P_o = 16.4$ psia—(base pressure)
$T_o = 520$ F absolute—(base temperature)
$T_f = 505$ F absolute—(flowing gas temperature)
$G = 0.670$—(gravity)
$D = 25.375$ in.—(26-in. by 5/16-in. pipe)
$L = 100$ miles
$E = 0.90$—(design problem)

Determine gas flow rate or Q

A. Calculate the P function.
From Fig. C:

$$P_1^2(1 + 2/3JP_1) = 899{,}000$$
$$P_2^2(1 + 2/3JP_2) = 386{,}000$$
$$513{,}000$$

Correction for base pressure, base temperature, flowing temperature, and gravity (Tables 2 to 5).

$$\frac{513{,}000}{F_{Po}\ F_{To}\ F_{Tf}\ F_G} = \frac{513{,}000}{(1.2396)\,(1)\,(.9712)\,(1.0296)}$$
$$= 414{,}000$$

B. Calculate equivalent length (Table 1)
$L_E = (100)\,(0.6654) = 66.54$ equivalent miles 24-in. by 5/16-in.

C. $$\frac{P_1^2(1 + 2/3JP_1) - P_2^2(1 + 2/3JP_2)}{L_E\ F_{Po}\ F_{To}\ F_{Tf}\ F_G} = \frac{414{,}000}{66.54}$$
$$= 6222$$

D. From Fig. B:
$Q = 355{,}300$ Mcfd for theoretically smooth pipe

For 0.90 roughness factor
$Q = 320{,}000$ Mcfd

No. 2

Given:

$P_1 = 800$ psia,
$Q = 230{,}000$ Mcfd,
$P_o = 14.40$ psia,
$T_o = 520$ F absolute,
$T_f = 535$ F absolute,
$G = 0.670$,
$L = 40$ mi 20-in. by ¼-in., and
25 mi 22-in. by 9/32-in. in series,
$E = 0.924$ (from previous flow test)

Determine P_2

A. Quantity at 1.00 roughness factor:

$$\frac{230{,}000}{0.924} = 249{,}000 \text{ Mcfd}$$

B. From Fig. B for the fixed conditions:

$$\frac{P_1^2(1 + 2/3JP_1) - P_2^2(1 + 2/3JP_2)}{L\ F_{Po}\ T_{To}\ F_f\ F_G} = 3100$$

C. Calculate equivalent length (Table 1)
$L_E = (40)\,(2.457) + 25\,(1.536) = 136.7$ equivalent miles 24-in. by 5/16-in.

D. Correction for base pressure, base temperature, flowing temperature and gravity.
$F_{Po} \cdot F_{To} \cdot F_f \cdot F_G = (0.9557)\,(1.0)\,(1.0288)\,(1.0296) = 1.012$

E. $P_1^2(1 + 2/3JP_1) - P_2^2(1 + 2/3JP_2) = (3100)\,(1.012)\,(136.7) = 428{,}900$

F. From Fig. C:
$P_1^2(1 + 2/3JP_1) = 688{,}100$
$P_2^2(1 + 2/3JP_2) = 688{,}100 - 428{,}900 = 259{,}200$
$P_2 = 498$ psia

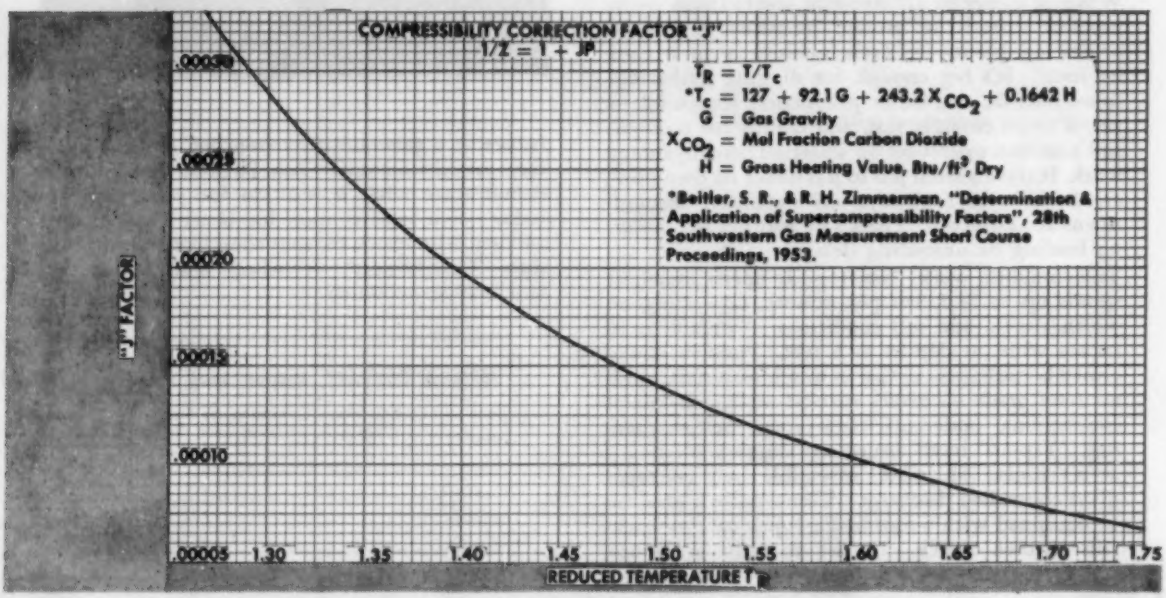

FIG. 1

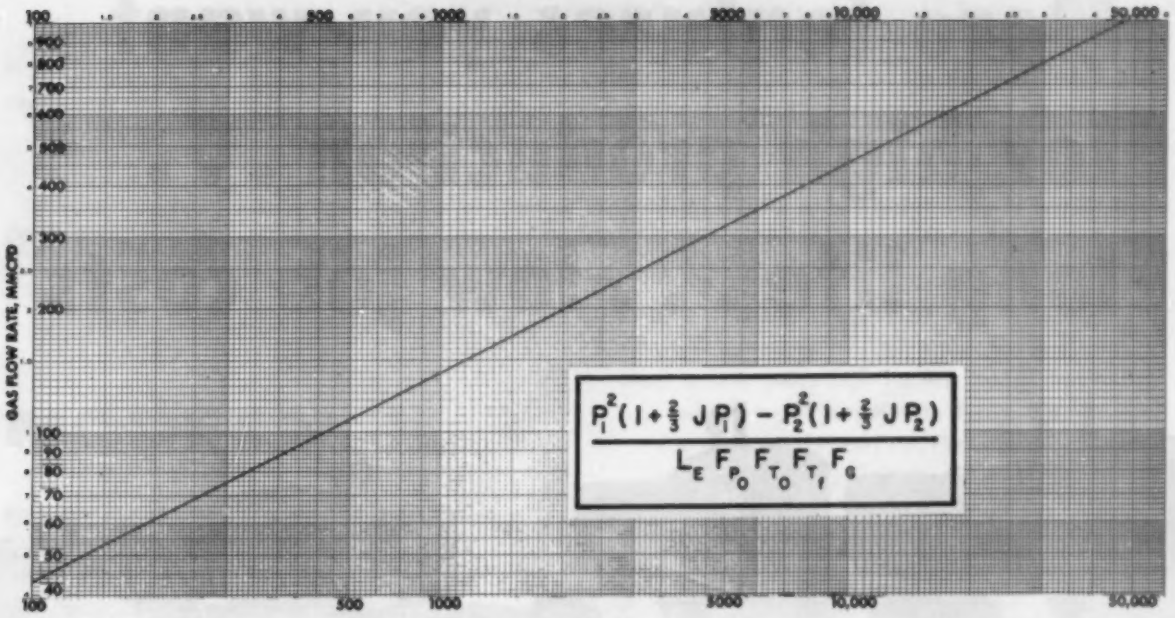

FIG. 2

No. 3

Given:

$P_2 = 525$ psia,
$Q = 700{,}000$ Mcfd,
$P_o = 14.73$ psia,
$T_o = 520$ F absolute,
$T_f = 520$ F absolute,
$G = 0.670$,
$E = 0.896$ (from test).

$$P_1 = \frac{35 \text{ Mi. } 24'' \times 5/16'' \mid 30 \text{ Mi. } 30'' \times 3/8''}{65 \text{ Mi. } 26'' \times 5/16''} - 525 \text{ psia}$$

Determine P_1

A. Quantity at 1.00 roughness factor:

$$\frac{700{,}000}{0.896} = 781{,}000 \text{ Mcfd}$$

B. From Fig. B for the fixed conditions:

$$\frac{P_1^2(1 + 2/3JP_1) - P_2^2(1 + 2/3JP_2)}{L_E \cdot F_{Po} \cdot F_{To} \cdot F_{Tf} \cdot F_G} = 29{,}200$$

C. Calculate equivalent length.

From Table 1:

$L_{E_1} = (35)(1.0) + 30(0.3288) = 44.86$
$L_{E_2} = 65(0.6654) = 43.25$

$$L_E = \left[\frac{1}{\left(\frac{1}{44.86}\right)^{0.510} + \left(\frac{1}{43.25}\right)^{0.510}}\right]^{1.961}$$

$= 11.31$ Equivalent miles 24-in. by 5/16-in.

D. Correction for base pressure, base temperature, flowing temperature, and gravity:

$F_{Po} \cdot F_{To} \cdot F \cdot F_G = (1.0)(1.0)(1.0)(1.0296) = 1.0296$

E. $P_1^2(1 + 2/3JP_1) - P_2^2(1 + 2/3JP_2) = (29{,}200)(11.31)(1.0296) = 340{,}000$

F. From Fig. C:

$P_2^2(1 + 2/3JP_2) = 291{,}000$
$P_1^2(1 + 2/3JP_1) = 291{,}000 + 340{,}000 = 631{,}000$
$P_1 = 764$ psia

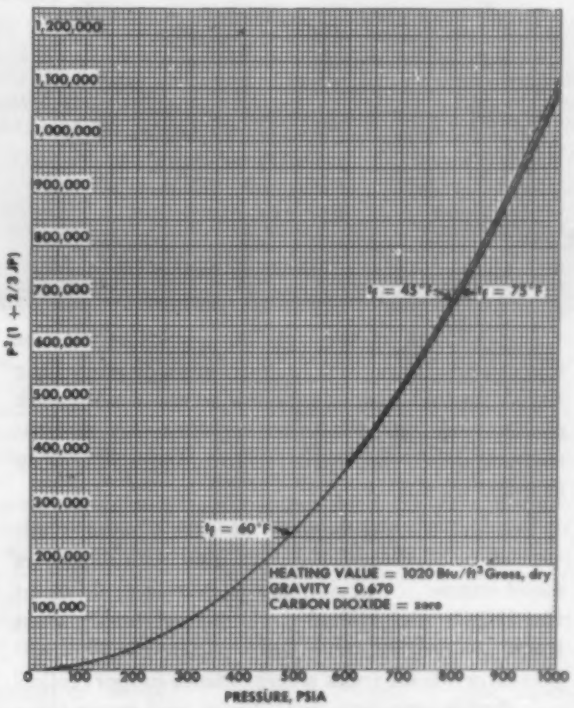

FIG. 3

Note: This is the first part of an article by these two authors on the revised Panhandle Formula. The second part will appear in the June issue of THE PETROLEUM ENGINEER.

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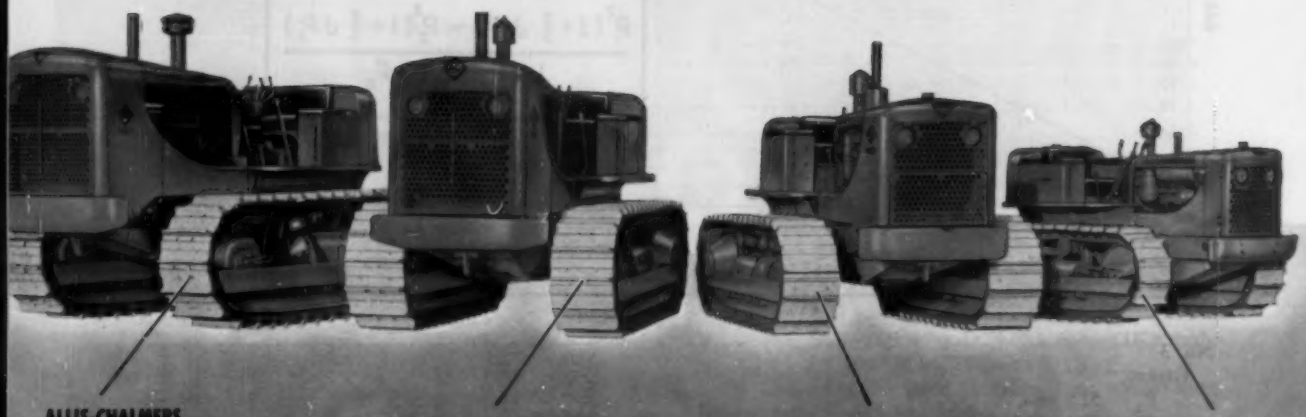

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Due to many requests for the series of articles "Design of Oil Pipe Lines," published in *The Petroleum Engineer* more than ten years ago, we asked the author, Fritz Karge, to revise the material for re-publication, adapting it to present day techniques. This he has done, and added a bibliography of recent articles.

This basic material, long unavailable either from the publishers or the author, will be presented in several installments.

Fritz Karge
Consulting Engineer

EXCLUSIVE

At the time the original series of articles was written Mr. Karge was chief engineer of the Pipe Line Department, Union Oil Company of California. Since his retirement a few years ago he has been engaged in consulting work, largely the design of pipe lines for water and heavy oil. He lives at 452 Mendoza Terrace, Corona del Mar, California. As indicated in the first paragraph of the article, this material first was prepared for students in the war training program. For that reason relationships of factors entering into the design of oil pipe lines are dwelt upon in considerable detail.

MODERN DESIGN OF OIL PIPE LINES

THIS material, in somewhat different form, was first delivered by the writer as one of a series of lectures at the University of Southern California, Los Angeles, War Training Program, Course No. 3113, P. L. Armstrong, instructor. Permission to use material presented in this course is hereby gratefully acknowledged.

The article deliberately does not delve into first causes of hydraulics; rather it accepts the painstaking work of scientists and engineers who brought forth formulas based on approximate theory but rectified by coefficients from experimental data. They have stood the test of time, if this term can be applied to a period of 40 to 50 years. Further refinements in the recognition of certain hydraulic phenomena are desirable and challenging. The ability, for instance, to predict more accurately the flow behavior of a cooling liquid between the upper and lower critical flow limits would be of value to the designing engineer.

The purpose of the article is to give a brief outline of the most important factors required for the design of oil pipe lines. It offers a graph (Graph 1) of "Friction Factors for Commercial Pipe" that is based on the article "The Flow of Fluids in Closed Conduits" by R. J. S. Pigott. The graph varies from the article only in some of the symbols for physical quantities. It will be referred to hereafter as the Pigott graph. A second chart is appended, "Friction Factor Chart for Fluid Flow in Pipes," also accepting Pigott's work but presenting formulas more conveniently manipulated on the slide rule. The chart is hereafter referred to as Graph 2.

Pigott's paper is to be found in "Mechanical Engineering," August, 1933. It summarizes the meat of an article by Emory Kemler, *Transaction* American Society of Mechanical Engineers, 1933, paper HYD 55-2. Kemler's work contains the most thorough critical comparison of flow test data ever undertaken. "From 10,000 to 12,000 individual tests were studied; all those in which the data were noticeably incomplete or subject to doubt were discarded. In the final work, approximately 4000 test points were used, from about 200 separate test series," Test data from operating oil pipe lines were included. The work of Kemler and Pigott has been accepted by many engineers and authorities in hydraulics.

It is assumed that the reader is familiar with the term "streamline" flow, also called direct, laminar or viscous, and with "turbulent" flow, often called sinuous. It is further assumed that the reader is acquainted with the several systems in use for denoting the viscosity of liquids.

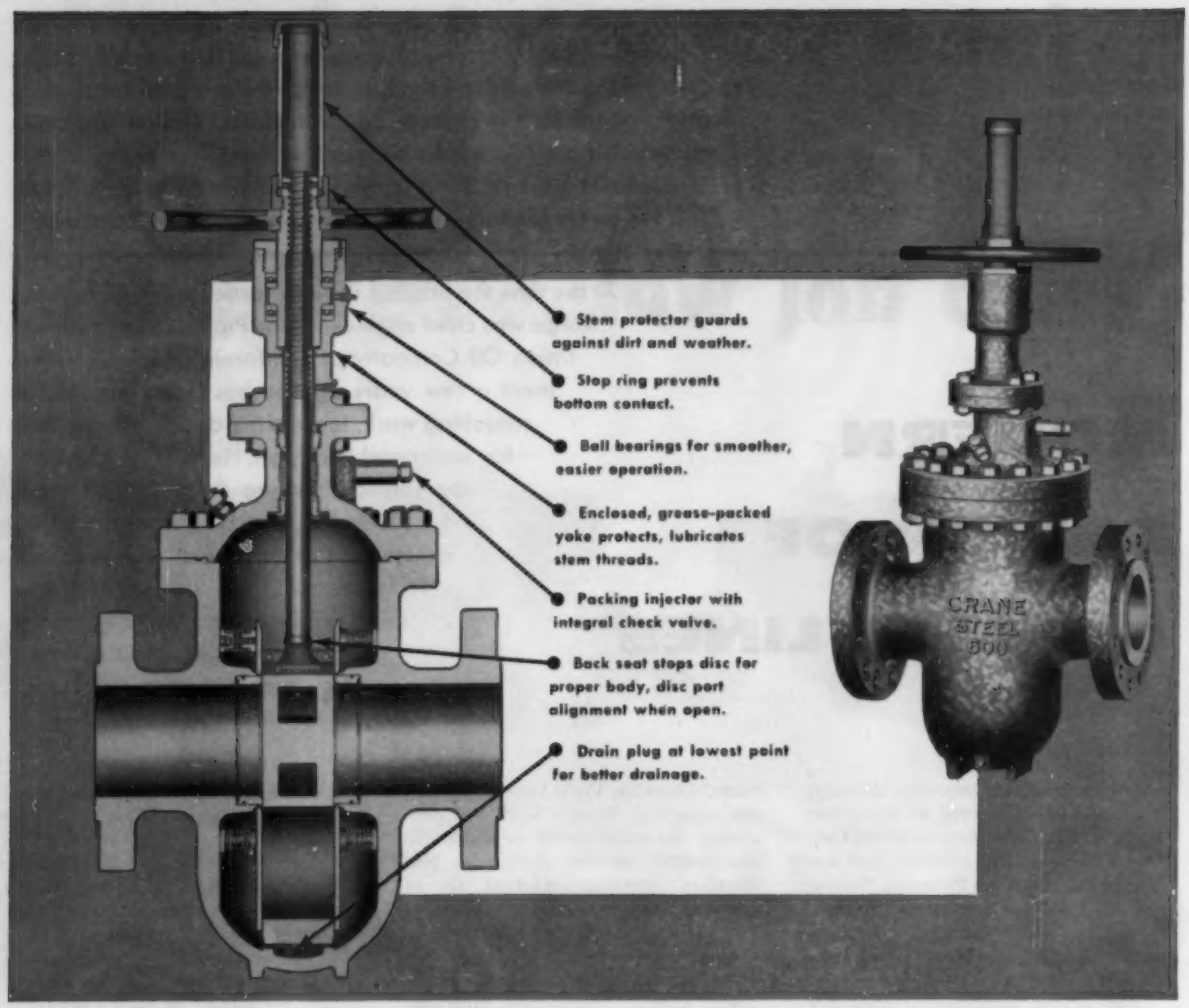
Before presenting the practical aspects of pipe line design, it appears desirable to review the most important flow formulas and their application; to dwell upon the function of the various factors, and to discuss the probable accuracy of the formulas.

Flow Formulas

The Pigott chart, as offered, lists a number of flow formulas using different factors, such as velocity of flow in feet per second, mass velocity in pounds per second, quantity flow in gallons per minute or barrels per hour. The pipe diameter is expressed in inches or feet, the viscosity in centimeter-gram-second units (cgs) or in pound-foot-second units (pfs). These and other formulas are in use and may be encountered on friction factor graphs published in magazines or technical books. If the formulas are set side by side, and if the different factors are converted to one single system of measurement, all will give the same end result. This must be so, for all are based on the same fundamental equations.

The formulas for streamline flow of oil follow the experiments of Poiseuille.

Fanning's formula of water underlies all given formulas for turbulent flow and the friction coefficient "f" in Fanning's formula is found by determining the Reynolds number, which by its magnitude indicates whether the flow is streamline or turbulent. The friction factor is the same for the same values of the Reynolds number and for the same size and kind of pipe irrespective of the nature of the fluid flowing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GRAPH 1. FRICTION FACTORS FOR COMMERCIAL PIPE

(Key table on following page of article)

Reynolds number of flow in pipes.

$$R_e = \frac{Dvp}{\mu_e} = \frac{124dvp}{\mu} = \frac{50.7Qp}{d\mu} = \frac{6.32W}{d\mu}$$

$$R_e = \frac{35.5Bp}{d\mu} = \frac{7742dv}{\nu} = \frac{3162Q}{\nu d}$$

Pressure drop for viscous flow conditions (Reynolds numbers less than 1200):

$$\triangle P = P_1 - P_2 = \frac{0.000669\mu Lv}{d^2}$$

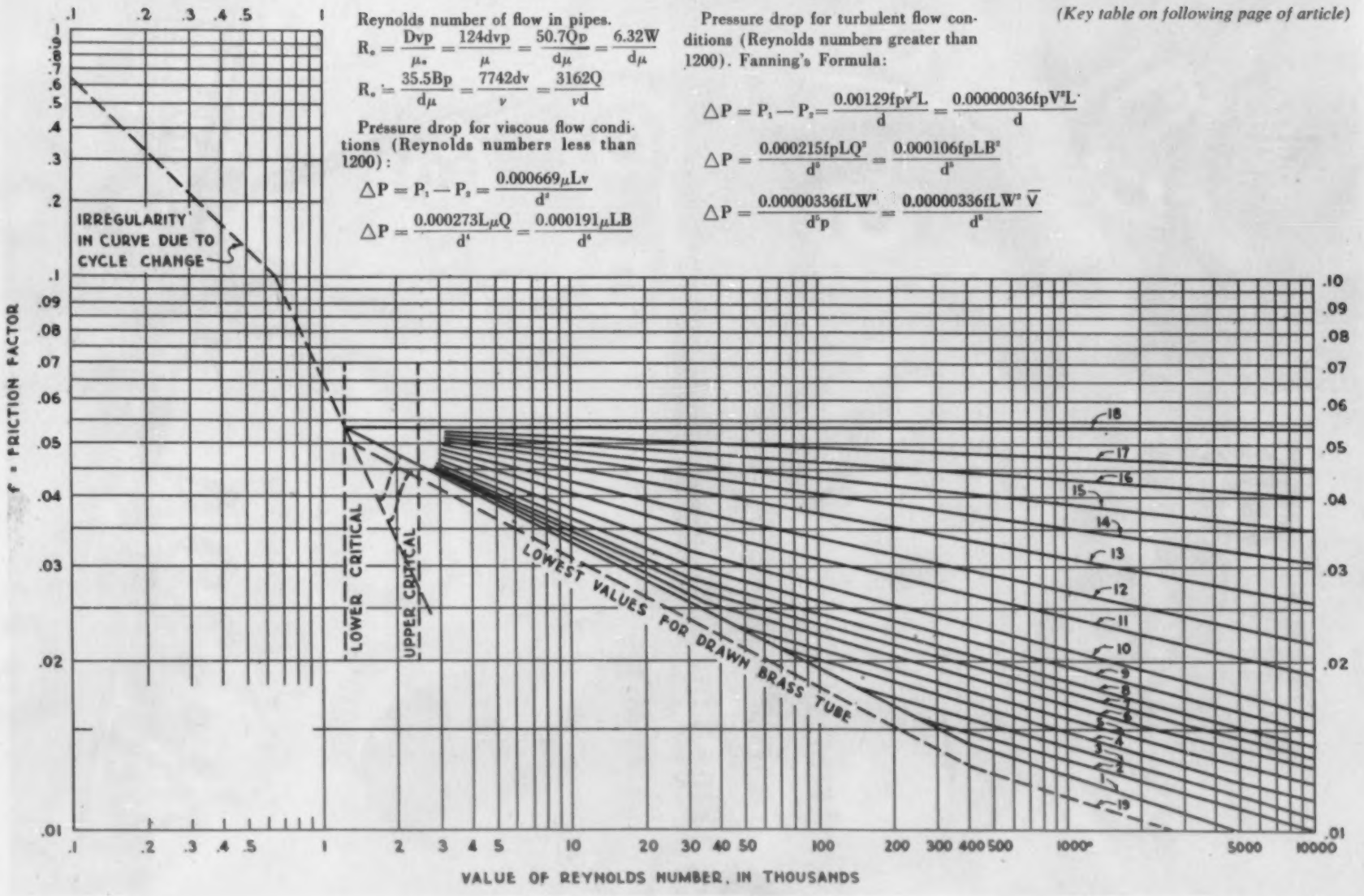
$$\triangle P = \frac{0.000273L\mu Q}{d^4} = \frac{0.000191\mu LB}{d^4}$$

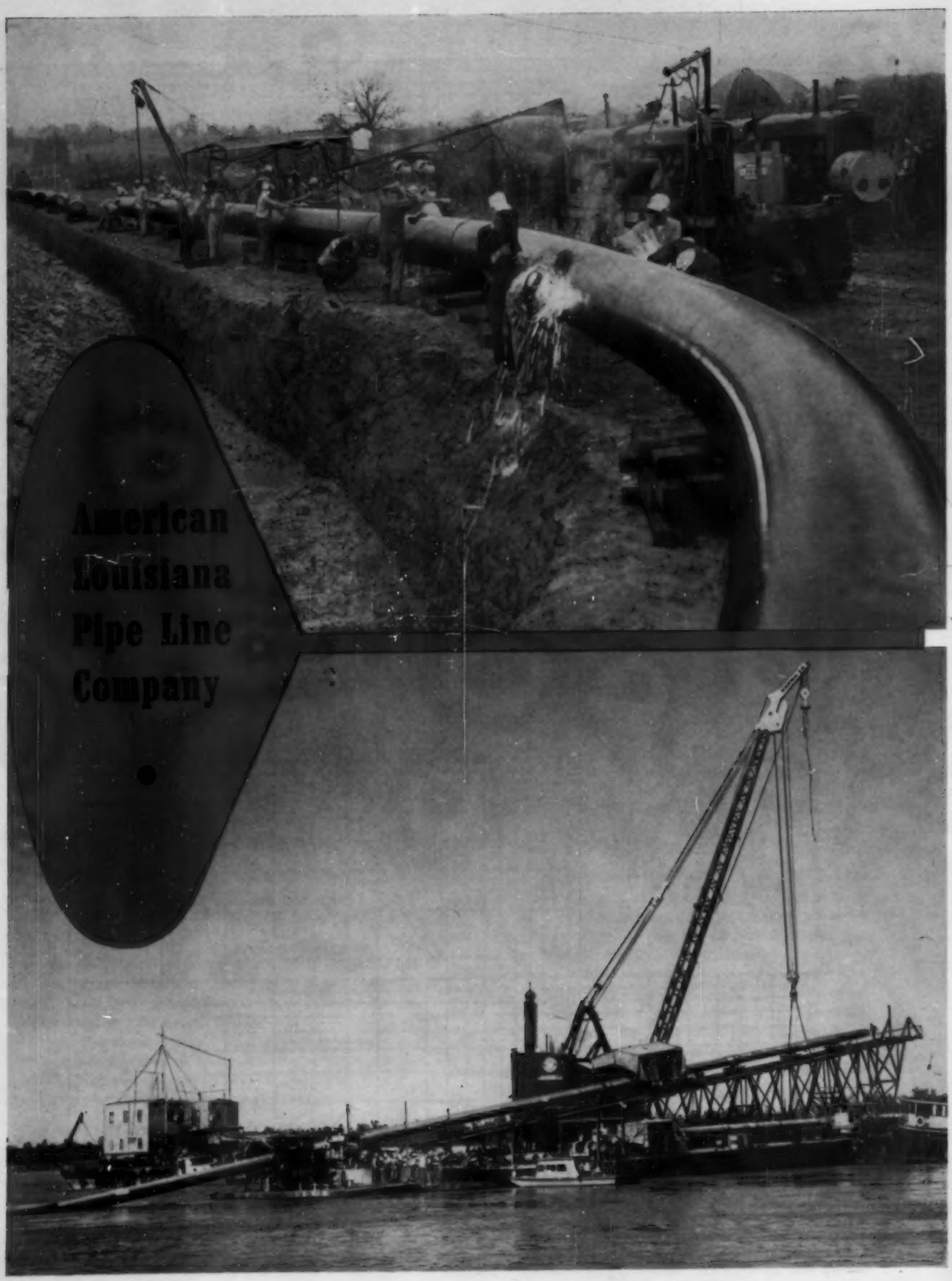
Pressure drop for turbulent flow conditions (Reynolds numbers greater than 1200). Fanning's Formula:

$$\triangle P = P_1 - P_2 = \frac{0.00129fpv^2L}{d} = \frac{0.00000036fpV^2L}{d}$$

$$\triangle P = \frac{0.000215fpLQ^2}{d^5} = \frac{0.000106fpLB^2}{d^5}$$

$$\triangle P = \frac{0.00000336fLW^2}{d^5p} = \frac{0.00000336fLW^2\,\overline{V}}{d^5}$$

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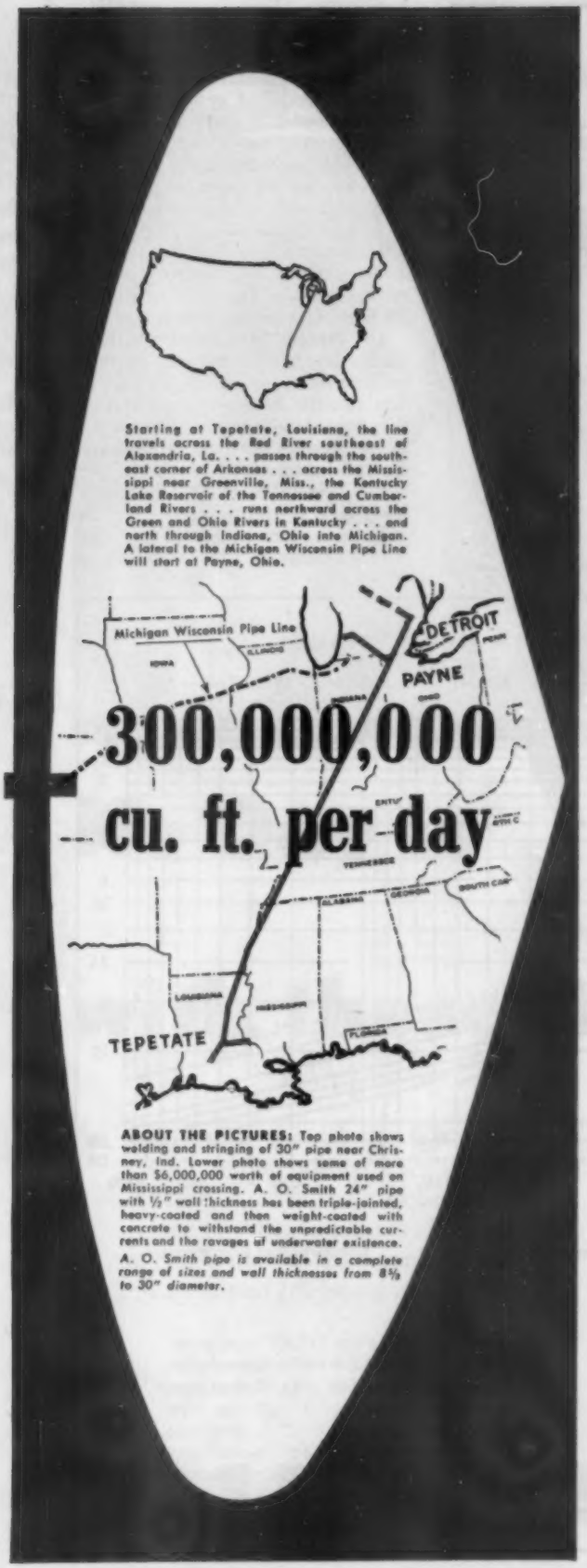
Starting at Tepetate, Louisiana, the line travels across the Red River southeast of Alexandria, La. . . . passes through the southeast corner of Arkansas . . . across the Mississippi near Greenville, Miss., the Kentucky Lake Reservoir of the Tennessee and Cumberland Rivers . . . runs northward across the Green and Ohio Rivers in Kentucky . . . and north through Indiana, Ohio into Michigan. A lateral to the Michigan Wisconsin Pipe Line will start at Payne, Ohio.
Michigan Wisconsin Pipe Line
DETROIT
PAYNE
300,000,000
cu. ft. per day
TEPETATE
ABOUT THE PICTURES: Top photo shows welding and stringing of 30" pipe near Chrisney, Ind. Lower photo shows some of more than $6,000,000 worth of equipment used on Mississippi crossing. A. O. Smith 24" pipe with ½" wall thickness has been triple-jointed, heavy-coated and then weight-coated with concrete to withstand the unpredictable currents and the ravages of underwater existence.
A. O. Smith pipe is available in a complete range of sizes and wall thicknesses from 8⅝ to 30" diameter.

793 Miles of A. O. Smith Line Pipe

THE new American Louisiana Pipe Line is being built to meet the tremendous requirements for additional supplies of natural gas in Michigan, Wisconsin and parts of Iowa and Missouri. When complete it will bring 300,000,000 cu ft of gas per day to these states. This capacity can be increased to 550,000,000 feet per day by the addition of compressor horsepower.

The main line will be 30" in diameter and extend 1000 miles from southern Louisiana to a connection with Michigan Consolidated Gas Company at Willow Run. It will cross 8 states and nine major rivers and lakes, marshes, swamps, rice fields, forests and the mountains of Tennessee, Kentucky and southern Indiana. Also, approximately 78 miles of 24" and 26" main line will be laid in southern Louisiana.

The pipe line system was designed by Ford, Bacon & Davis, Inc., and construction is being done by H. C. Price Company, Houston Construction Company and Brown & Root, Inc.

A. O. Smith Corporation played an important part in this new line by furnishing 758 miles, over 75%, of the 30" pipe from its Houston Mill, A. O. Smith Co. of Texas, and 35 miles of the 26" pipe, together with the 24" heavy wall pipe used for the major river crossings, from its Milwaukee Mill.

For almost 30 years A. O. Smith has held a high-standard of quality control and this quality control has been maintained at every step of the manufacturing process. That's why A. O. Smith pipe made and installed in 1928 is still in operation. That's why so much A. O. Smith pipe has been used in nearly every important high pressure line.

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Milwaukee 1, Wisconsin

Chicago 4 • Dallas 2 • Los Angeles 22 • Midland 5, Texas • New Orleans 12 • New York 17 • Pittsburgh 19 • San Francisco 4 Seattle 1 • Tulsa 3 • Washington 6, D. C.

International Division: Milwaukee 1, Wisconsin

Key Table for Graph 1

Curve number	Roughness, per cent	Diameter of pipe in inches					
		Type A	Type B	Type C	Type D	Type E	Type F
1	0.2	0.35 up	72	....	....	....	....
2	0.45	....	48 to 66	....	....	....	....
3	0.81	....	14 to 42	30	48 to 96	96	220
4	1.35	....	6 to 12	10 to 24	20 to 48	42 to 96	84 to 204
5	2.1	....	4 to 5	6 to 8	12 to 18	24 to 36	48 to 72
6	3.0	....	2 to 3	3 to 5	5 to 10	10 to 20	20 to 42
7	3.8	....	1½	2½	3 to 4	6 to 8	16 to 18
8	4.8	....	1 to 1¼	1 to 2	2 to 2½	4 to 5	10 to 14
9	6.0	....	¾	1¼	1½	3	8
10	7.2	....	½	1	1¼	....	5
11	10.5	....	⅜	¾	1	....	4
12	14.5	....	¼	½	....	....	3
13	19.0	....	⅛	....	....	....	....
14	24.0	0.125	....	¼	....	....	....
15	28.0	....	....	....	....	....	....
16	31.5	....	....	⅛	....	....	....
17	34.0	....	....	....	....	....	....
18	37.5	0.0625	....	⅛	....	....	....

Type A—Drawn tubing and brass, tin, lead, and glass pipe.
Type B—Clean steel and wrought iron pipe.
Type C—Clean galvanized pipe.
Type D—Best cast iron pipe, cement and light riveted sheet ducts.
Type E—Average cast iron pipe and rough formed concrete ducts.
Type F—First class brick heavy riveted and spiral riveted ducts.
Note: In drawn tubing the actual inside diameter is given. In pipe, the nominal size of standard weight is given.

in the pipe.

If an engineer is frequently called upon to design oil pipe lines, whether short ones for a refinery plant or longer ones for an oil field, or wherever long lines are needed, it seems advisable for him to make himself thoroughly familiar with one formula for streamline flow and one for turbulent flow, and then to lay aside all others. Which formula is he to choose?

The writer's experience has led him to the adoption of formulas in which the flow rate is expressed in barrels per hour. The reasons follow:

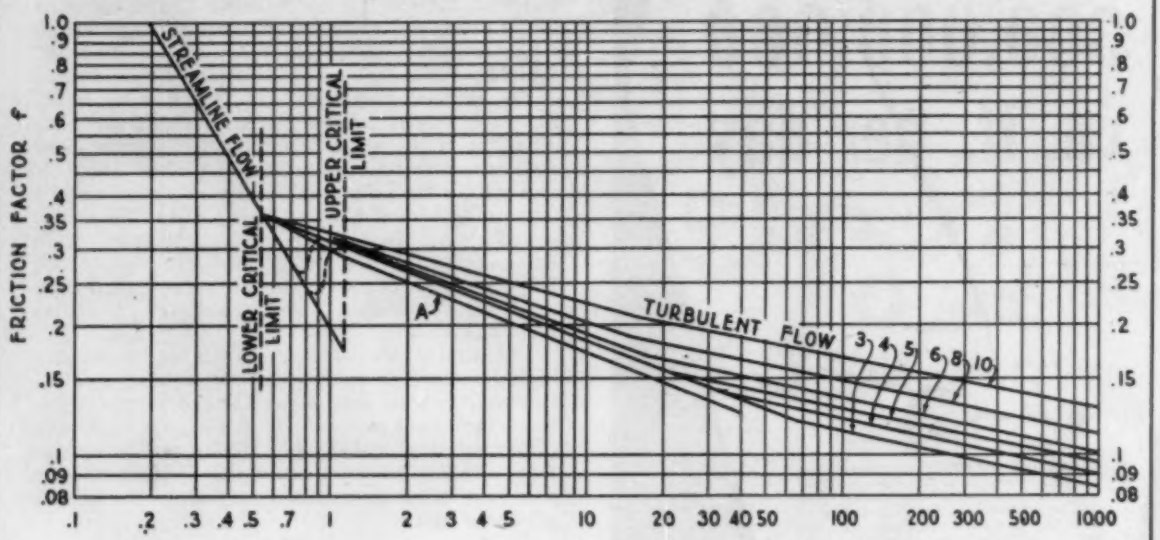
The capacity of a refinery plant is usually given in barrels per day, and the flow sheets for such plants use that flow rate for all interconnecting pipe lines more frequently than gallons per minute, pounds per hour, or other systems of measurements.

The capacity of an oil well or of a whole field is usually expressed in the same term, namely, barrels per day.

When designing a tanker loading or

GRAPH 2. FRICTION FACTOR CHART FOR FLUID FLOW IN PIPE LINES

References: 1. The flow of fluids in closed conduits — R.J.S. Pigott, *Mech. Eng.*, Aug., 1933.
2. A study of the data on the flow of fluids in pipes — Emory Kemler, *Trans., A.S.M.E.*, 1933, Hyd. — 55.2.



For streamline flow $P = \frac{.191\ Q\ z}{d^4}$ Reynolds number $R = \frac{Q}{d\ \frac{z}{s}}$ For turbulent flow $P = f\ \frac{sQ^2}{d^5}$

P = pressure drop per 1000 ft in psi.
f = friction factor
s = specific gravity of fluid at flow conditions.
Q = quantity, bbl per hr.
d = actual pipe diameter, in.
z = absolute viscosity, centipoises.
$\frac{z}{s}$ = kinematic viscosity, centistokes.

3 = Pigott curve for 14″ 42″ steel pipe.
4 = Pigott curve for 6″ 12″ steel pipe.
5 = Pigott curve for 4″ 5″ steel pipe.
6 = Pigott curve for 2″ 3″ steel pipe.
8 = Pigott curve for 1″ steel pipe.
10 = Pigott curve for ½″ steel pipe.
A = St. Oil of Cal. and Wm. G. Heltzel Curve (average) 6″—12″.

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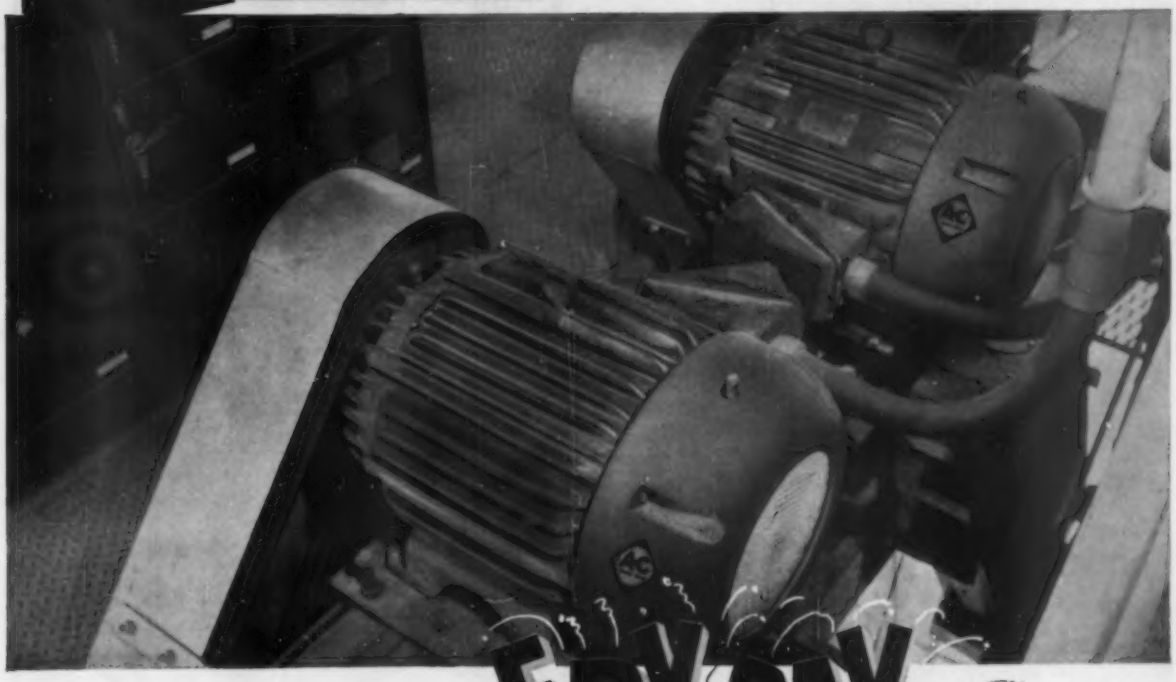

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unloading line, the flow requirements will usually be stated in barrels per hour.

Barrels per day is easily changed to barrels per hour, and this term is understood by all men engaged in oil operations, whether they pump oil wells, gage tanks hourly at a pump station to record the number of barrels handled during the previous hour, control the flow of oil to or from a still or other refinery unit, or whether they supervise the filling or emptying of a tanker.

No potent reason seems to exist for complicating design calculations by changing the barrels per hour term to gallons per minute, pounds per hour, feet velocity per second or some other system. Why not use the term in which the capacity requirement of the pipe line will very likely be stated?

It further seems that design calculations should be made uniform by expressing the viscosity in the terms approved by the American Standards Association and American Petroleum Institute in 1939 and shown in the accompanying table which is reprinted from the publication of the American Society for Testing Materials. This publication gives the approved method for converting Saybolt universal viscosity in seconds to kinematic viscosity. It adopts the following nomenclature:

Absolute viscosity is expressed in poises (cgs unit) or centipoises.

Kinematic viscosity, being equal to the absolute viscosity divided by the specific gravity, is expressed in stokes or centistokes. The stoke is here also the cgs unit.

A measure of simplification results from the adopted practice, for the descriptive adjectives "absolute" and "kinematic" are unnecessary, being implied in the terms "poises" and "stokes," respectively.

When a sample of oil is sent to the laboratory for the determination of its viscosity, a Saybolt viscosimeter will very likely be used, or an Oswald viscosimeter. The viscosity will be reported in Saybolt universal second units for light oils and in furol units for heavy oils. Conversion of the Saybolt viscosity to kinematic viscosity in stokes is easy when Table 1 is used, or any of the many conversion charts. The kinematic viscosity in stokes, multiplied by the specific gravity at the same temperature, gives the absolute viscosity in poises.

The absolute viscosity of water at 69 F is 1 centipoise. The centipoise viscosity value of an oil, therefore, indicates how many times stickier the oil is than water. Although not much value lies in the knowledge of this relationship, it is of interest. The poise

Approved as American standard by American Standards Association, ASA No. Z11.46-1941. American Petroleum Institute Standard, API No. 534-39.

STANDARD METHOD FOR CONVERSION OF KINEMATIC VISCOSITY TO SAYBOLT UNIVERSAL VISCOSITY[1]

ASTM Designation: D 446-39. Adopted 1939[2]

This Standard of the American Society for Testing Materials is issued under the fixed designation D 446; the final number indicates the year of original adoption as standard or, in the case of revision, the year of last revision.

Scope

1. The conversion table and equation included in this method provide a means for converting kinematic viscosity in centistokes at any temperature to Saybolt universal viscosity in seconds at the same temperature.[3]

Description

2. The Saybolt universal viscosity equivalent to a given kinematic viscosity[4] varies with the temperature at which the determination is made. The basic conversion values are those given in Table 1 for 100 F. The Saybolt universal viscosity equivalent to a given kinematic viscosity at any temperature may be calculated as described in Section 3. Equivalent values at temperatures of 130 and 210 F are given in Table 1 for convenience.[5]

Procedure

3. For conversions at 100, 130, and 210 F, the equivalent Saybolt universal viscosity values may be read directly from Table 1. For kinematic viscosities between 2 and 70 centistokes that are not listed in Table 1, the equivalent Saybolt universal viscosity values may be obtained by linear interpolation. For kinematic viscosities over 70 centistokes, the Saybolt universal viscosity equivalent may be calculated by use of the multiplication constant given in Table 1 corresponding to the proper temperature. The Saybolt universal viscosity equivalent to a kinematic viscosity determined at t F may be calculated by multiplying the equivalent Saybolt universal viscosity at 100 F by $1 + (t - 100)\ 0.000064$.

Supplementary Conversion Equivalents

4. The following equivalents are frequently used in connection with viscosity conversions:

Poise = cgs unit of absolute viscosity
Centipoise = 0.01 poise
Stoke = cgs unit of kinematic viscosity
Centistoke = 0.01 stoke
Centipoises = centistokes × density (at temperature under consideration)
Reyn (1 lb-sec per sq in.) = 69×10^5 centipoises

TABLE 1. Values for converting kinematic viscosity to Saybolt universal viscosity

Kinematic viscosity, centistokes	Equivalent Saybolt universal viscosity, sec.			Kinematic viscosity, centistokes	Equivalent Saybolt universal viscosity, sec.		
	At 100 F (basic values, see note)	At 130 F	At 210 F		At 100 F (basic values, see note)	At 130 F	At 210 F
2	32.6	32.7	32.8	31	145.3	145.6	146.3
2.5	34.4	34.5	34.6	32	149.7	150.0	150.7
3	36.0	36.1	36.3	33	154.2	154.5	155.3
3.5	37.6	37.7	37.9	34	158.7	159.0	159.8
4	39.1	39.2	39.4	35	163.2	163.5	164.3
4.5	40.7	40.8	41.0				
5	42.3	42.4	42.6				
6	45.5	45.6	45.8	36	167.7	168.0	168.9
7	48.7	48.8	49.0	37	172.2	172.5	173.4
8	52.0	52.1	52.4	38	176.7	177.0	177.9
9	55.4	55.5	55.8	39	181.2	181.5	182.5
10	58.8	58.9	59.2	40	185.7	186.1	187.0
11	62.3	62.4	62.7	41	190.2	190.6	191.5
12	65.9	66.0	66.4	42	194.7	195.1	196.1
13	69.6	69.7	70.1	43	199.2	199.6	200.6
14	73.4	73.5	73.9	44	203.8	204.2	205.2
15	77.2	77.3	77.7	45	208.4	208.8	209.9
16	81.1	81.3	81.7	46	213.0	213.4	214.5
17	85.1	85.3	85.7	47	217.6	218.0	219.1
18	89.2	89.4	89.8	48	222.3	222.6	223.8
19	93.3	93.5	94.0	49	226.8	227.2	228.4
20	97.5	97.7	98.2	50	231.4	231.8	233.0
21	101.7	101.9	102.4	55	254.4	254.9	256.2
22	106.0	106.2	106.7	60	277.4	277.9	279.3
23	110.3	110.5	111.1	65	300.4	301.0	302.5
24	114.6	114.8	115.4	70	323.4	324.0	325.7
25	118.9	119.1	119.7				
26	123.3	123.5	124.2	Over 70	Saybolt seconds = centistokes × 4.620	Saybolt seconds = centistokes × 4.629	Saybolt seconds = centistokes × 4.653
27	127.7	127.9	128.6				
28	132.1	132.4	133.0				
29	136.5	136.8	137.5				
30	140.9	141.2	141.9				

NOTE—To obtain the Saybolt universal viscosity equivalent to a kinematic viscosity determined at t F multiply the equivalent Saybolt universal viscosity at 100 F by $1 + (t - 100)\ 0.000064$; for example, 10 centistokes at 210 F are equivalent to 58.8×1.0070 or 59.2 Saybolt universal seconds at 210 F.

[1] Under the standardization procedure of the Society, this method is under the jurisdiction of the ASTM Committee D-2 on Petroleum Products and Lubricants.

[2] Prior to adoption as standard, this method was published as tentative from 1937 to 1939.

[3] See paper by C. E. Headington and J. C. Genlesse, "Method for Converting Kinematic Viscosity to Saybolt Universal Viscosity," *Proceedings*, American Society Testing Materials, Vol. 37, Part I, p. 380 (1937).

[4] The test procedure for determining kinematic viscosity is described in the Tentative Method of Test for Kinematic Viscosity (ASTM Designation: D 445) and the test procedure for Saybolt Universal Viscosity appears in the Standard Method of Test for Viscosity by means of the Saybolt Viscosimeter (ASTM Designation: D 88), see pp. 338 and 347.

[5] In order to avoid unnecessary interpolation, tables based on this method may be employed. ASTM Conversion Tables for Kinematic and Saybolt Viscosities are published separately and copies may be obtained from Society headquarters, 1916 Race Street, Philadelphia 3, Pennsylvania.

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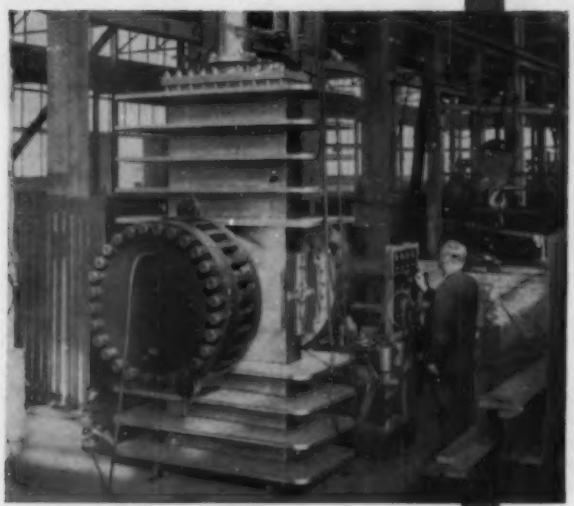

34" full opening gas line valve being tested before shipment for free gate movement, bubble-tight seal.

24" full opening valve being subjected to 600-ton compression load. Gate maintained free movement.

THE WHOLE VALVE IS RIGHT HERE

When valve is full open or closed, bubble-tight seals on both sides of the gate completely isolate line pressure in the conduit. The body, serving merely as framework for operating mechanism and to prevent loss of product while gate is in motion, may be drained or vented to atmosphere when gate is open or closed. Integrity of seals can be checked any time by a tell-tale valve on the body.

Engineered and built specifically for pipeline service, every Grove Seal-O-Ring fabricated steel body is tested at *double its rated working pressure*. This subjects it to tension far greater than anything it might be expected to face in the field—and at the same time relieves any existing stresses in the body itself.

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was named in honor of Poiseuille, who gave to the world the formula for streamline flow.

As previously stated, the formulas hereafter presented are those that the writer has found most simple to manipulate. As far as he knows they were first employed by Danforth, referred to below. As will be pointed out, they permit the designer to visualize readily the effect upon the result of a change in any one of the factors. They are not given for the purpose of persuading the reader to adopt them for use, rather to show how any one of the several flow formulas on the Pigott graph (Graph 1) can be juggled to one that the reader will find practicable. The problems can also be solved by means of the many diagrams designed and issued by various engineers. Some of them have a separate diagram for each of the commonly used commercial sizes of pipe. The best known of this type is the set worked out by R. S. Danforth for the Kinney Manufacturing Company, published in 1920. The pressure drop per 1000 ft of pipe, read on these diagrams, is on the safe side. Other published graphs combine all sizes of pipe on one sheet. They are less simple to read and interpret. Crane Company presents in Technical Paper No. 409 of May, 1942, a set of nomographs for taking off the pressure drop for streamline and turbulent flow. This paper contains also a good bibliography of papers and books for a more detailed study.

The writer uses such charts for quick estimates of pressure drop or for checking calculations. He does not use them for design purposes because no record is left of the progressive steps in the solution of the problem. Most charts, furthermore, are designed for standard weight pipe. Corrections must be applied when lighter weight pipe is under consideration.

Any engineer is at liberty also to design a diagram to his particular taste. He will find it stimulating entertainment that will give an insight into the mathematics involved and an acquaintance with the effect of changes in the value of the various factors that otherwise can be gained only by many design calculations.

The writer will return to this subject later, and it is hoped that the several emphases laid upon the desirability of thoroughly acquainting oneself with the mathematics of flow formulas will enable the designer, if followed, to use this tool with skill and understanding.

Streamline Flow

The simplest formula is one adopted from Poiseuille's*, reading as follows:

$$P = \frac{19.1\,Q\,Z}{d^4}$$

In which:

P = lb pressure per sq in. per 1000 ft of pipe line. For other lengths, P is proportional.

Q = bbl per hr of 42 U. S. gal.

Z = absolute viscosity in poises.

d = inside pipe diameter, in.

(The writer pleads guilty of inconsistency in employing the letter Q as the symbol for barrels per hour and Z for absolute viscosity in poises, whereas the Pigott graph uses B and the Greek letter mu, respectively.)

For some purposes it is more convenient to express the friction loss in feet head. The formula then reads:

$$H = \frac{44.12\,Q\frac{Z}{s}}{d^4}$$

In which:

H = ft of head per 1000 ft of pipe.

$\frac{Z}{s}$ = kinematic viscosity in stokes.

There is no need to show the derivation of these formulas here. They are merely transpositions of the third formula for viscous flow on the Pigott chart. Attention is called to the fact that P varies directly as Q and Z, and inversely as the fourth power of the pipe diameter. The effect upon P of a change in the magnitude of the flow rate, viscosity or pipe diameter can, therefore, easily be visualized and calculated, if desirable. H is similarly affected, varying directly with Q and $\frac{Z}{s}$ and inversely as the fourth power of the pipe diameter.

Expressing the viscosity in centipoises, the constants in the given formulas will become 0.191 and 0.4412, respectively.

Reynolds Number**

The formulas were given before mentioning the test that must be made to assure the reader of their applicability to the design problem before him. As they apply only to pipe lines in streamline flow, it is first necessary, by means of the Reynolds number, to determine the condition of flow for the quantities involved.

Again the question arises which of the several formulas presented on the Pigott graph (Graph 1) to use. Following previous reasoning, it appears best to become thoroughly familiar with one formula and that the simplest. Graph 2, with formulas designed on the basis of the Pigott graph, meets all requirements of simplicity. The Reynolds number is expressed as follows:

$$R = \frac{Q}{d\,\frac{z}{s}}$$

In which:

Q = bbl per hr.

d = diameter of pipe, in.

$\frac{z}{s}$ = kinematic viscosity in centistokes at mean flowing temperature.

This expression can easily be deduced from the fourth formula for R on the Pigott graph. $R = \frac{35.5\,Br,}{dz}$ by substituting for "r," weight of liquid per cubic foot, its equivalent "62.5 × s," in which 62.5 is the weight of a cubic foot of water at 60 F, and s the specific gravity of the oil at the flowing temperature. The value of the equation will not be changed if s is moved from its position in the dividend to that of a divisor of z.

$$R = \frac{35.5 \times 62.5 \times B}{d\,\frac{z}{s}}$$

In which:

B = bbl per hr.

d = diameter of pipe, in.

$\frac{z}{s}$ = kinematic viscosity in centistokes.

The only difference between this equation and that used on the graph is the presence of the constant 35.5 × 62.5 Why not eliminate the necessity for manipulating this constant in every calculation? This was done by plotting the "f" values pertaining to the R values with the constant against the respective R values without the constant. In this simple R equation the effect of a change in the flow rate, in the diameter, or in the viscosity can easily be visualized and calculated.

The pipe line will be in streamline flow for an R value of 0.54 and less, when the viscosity is expressed in centipoises. If poises are preferred, the value will be 54. All other R values will then become 100 times as great as used in this graph. All R values higher than 1.13 definitely indicate turbulent flow. These two values of R are called the lower and upper critical flow limits. For R values between these limits, the flow might be either streamline or turbulent. Further discussion of the "f" factor to use will follow later.

Returning to a previous statement: The formula given for a pipe line in streamline flow must be used only after it has been determined by means of the Reynolds number that the flow will be streamline.

(Part 2 of this article will be published in an early issue.)

*Poiseuille's classical "Experiments on The Flow of Liquids in Capillary Tubes" (1842).

**Prof. Osborne Reynolds, "An Experimental Investigation of the Circumstances Whether the Motion of Water Shall Be Direct (Viscous or Streamline) or Sinuous (Turbulent) Philosophical Transactions" (1883).

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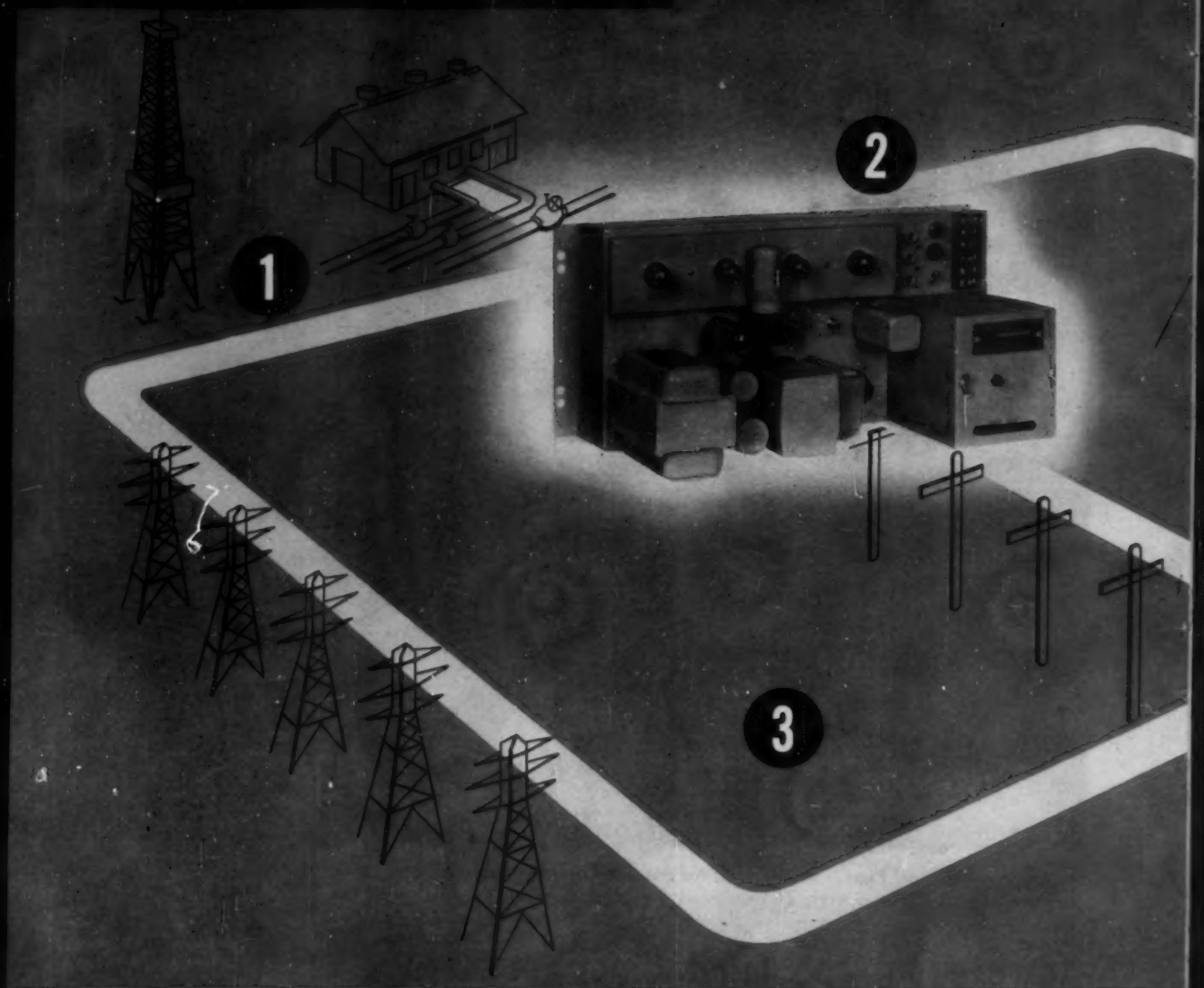

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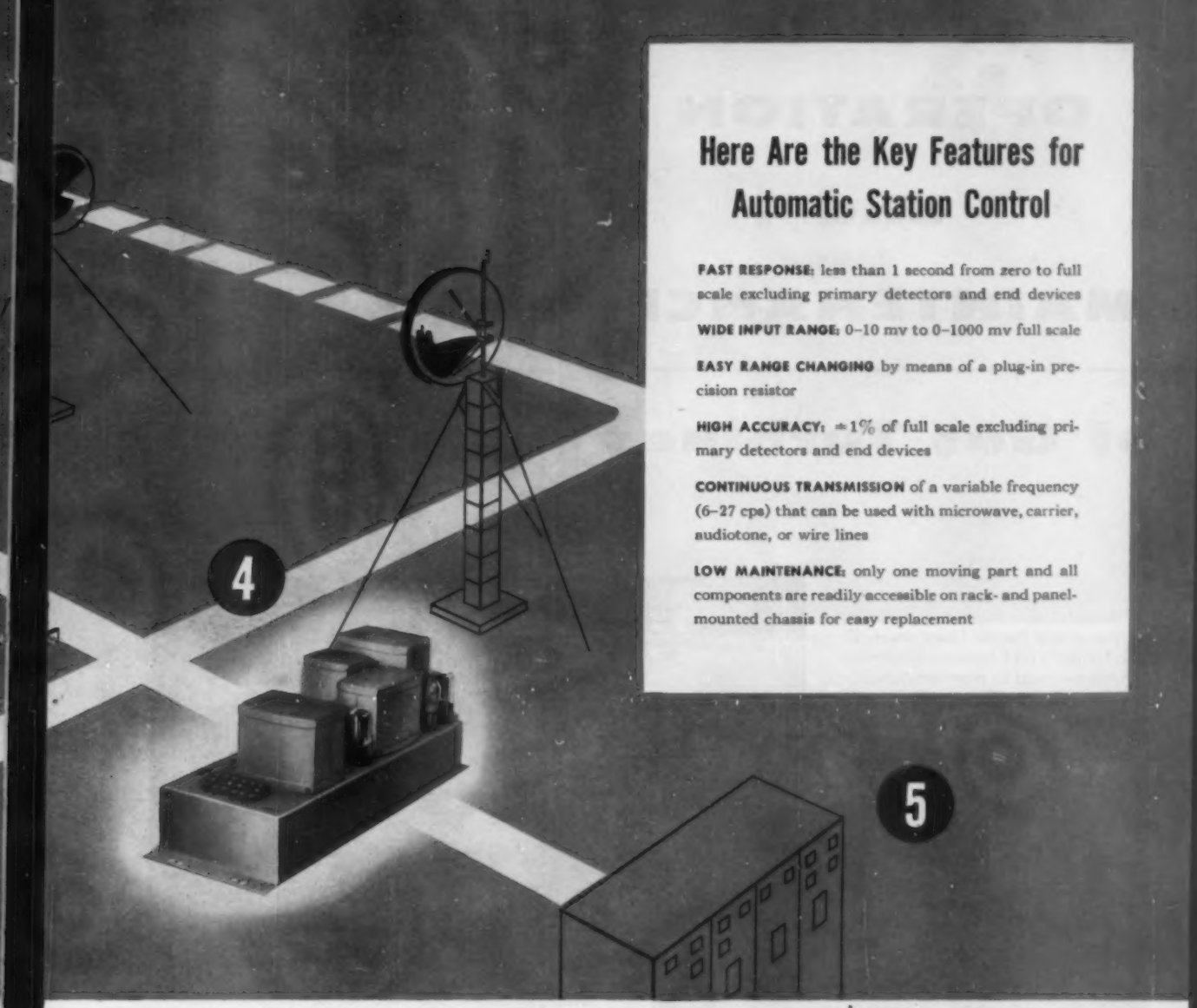

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EXCLUSIVE

OPERATION and MAINTENANCE of Gas Turbines

El Paso Natural, first to install gas turbines and centrifugal compressors on major scale, is systematically dismantling and inspecting units to determine mechanical condition.

E. A. Walsh
Division Engineer
El Paso Natural Gas Company

IN 1951, due to a constantly increasing demand for natural gas in the Southwest and Pacific Coast areas, El Paso Natural Gas Company was forced to further expand its pipe line capacity.

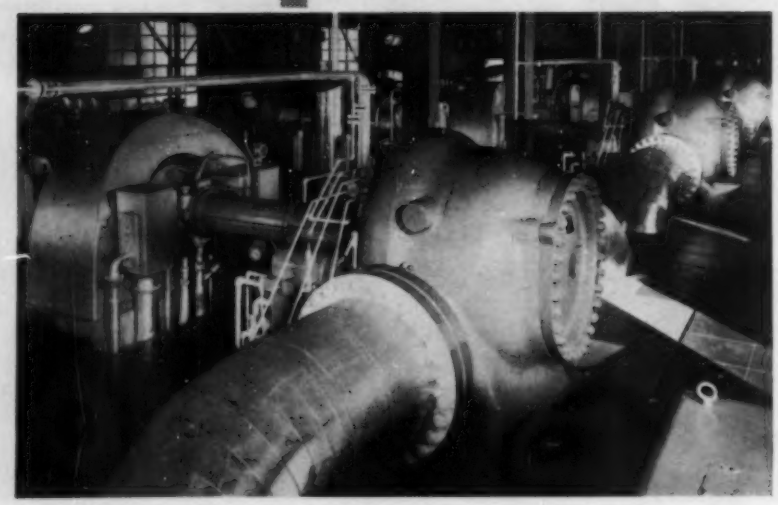
As a means of accomplishing this, the company elected to install new compressor stations along certain portions of its main line loop, which extends from West Texas across New Mexico and Arizona to the California border.

After a thorough study of the various factors involved, the company took a pioneering step by installing natural gas-fired gas turbines and centrifugal compressors. Installation of the units by El Paso Natural marked the first time they were used on such a large scale for the transmission of natural gas.

Because the turbines were new to the company, as well as to the industry, El Paso engineers conducted a study for the purpose of arriving at some estimate of how long the gas turbines could be expected to operate before a general inspection or overhaul was necessary.

On the basis of available information, the engineering department theorized that the turbines should achieve a minimum of 30,000 operating hours between major overhauls.

As of this date, most of the company's gas turbine units have been in continuous operation for periods ranging up to 20,000 hr. At varying times during the next year, however, most of the units will reach a crucial point of operation when they will have been functioning 30,000 hr.



THIS INTERIOR VIEW of El Paso Natural Gas Company's Hueco compressor station, 25 miles east of El Paso, Texas, shows a series of three centrifugal compressors.

It is when they reach this stage that company engineers will be able to appraise more definitely their operating performance.

The company placed the first of 28 gas turbine-driven centrifugal compressor units in operation in September, 1952, and the last of the group in December, 1953.

Representing a total spread of 140,000 hp, the turbine stations are located at intervals along 750 miles of El Paso Natural's 26-in. and 30-in. loop line that moves gas from the Permian Basin of West Texas and southeastern New Mexico to California.

The compressors, designed to increase the flow of gas from approximately 800,000,000 std cu ft a day to approximately 1,100,000,000 std cu ft, are situated at intervals about 35 miles apart between existing reciprocating stations.

As most of the El Paso booster stations are in remote, semi-arid country, the turbine units offer several advantages.

They are essentially simple rotating machines and are complete, self-sustaining power plants in themselves, taking fuel directly from the pipe line and requiring little or no water and no outside electrical power.

Most of the functions and protec-

ON 63 MILES OF 36-INCH LOOP requiring trench 6½ feet deep to allow a 30-inch cover for oversize pipe, Associated Pipe Line Contractors, Inc. got high daily footage with two Cleveland 320 Pipeline Trenchers. The job was split into two work sections, one running westward from Magnolia, Miss. to Clinton, La., the other eastward from White Bluff to Collins, Miss.

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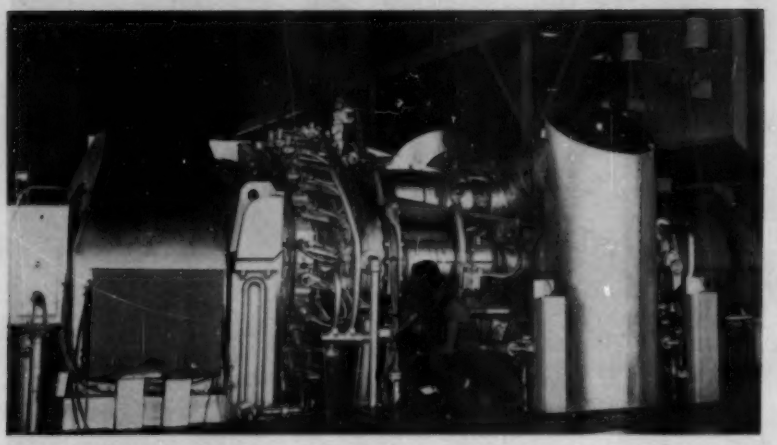

AMONG THE FIRST of 28 gas turbine units placed in operation by El Paso Natural Gas Company was this 5000-hp unit at Cornudas station, about 65 miles east of El Paso. Placed in operation in September, 1952, the unit has been operating continuously for approximately 22,000 hr.

tive features of the gas turbines are entirely automatic.

The 10 El Paso Natural stations are comprised of both two-unit and three-unit gas turbines. Each unit is rated at 5000 hp at 80 F and 1000 ft altitude.

Check Made on Costs

Ever since the stations were placed in operation, a more or less running check has been kept on them to determine their maintenance and operating costs.

The most effective way of accomplishing this has been to tear down and completely inspect turbines at various stations.

Specially trained maintenance crews break the units down and examine them very closely for any type of flaw, from an imperfection in manufacturing to a defect resulting from operations.

Turbine units so far dismantled by maintenance workers have varied in their length of operations, all the way from 8000 hr to 18,000 hr.

As deliveries during the winter season are at their peak, maintenance crews have been working at the far western end of the system where requirements for compressor horsepower are not as critical as on the other end of the line.

So far, the workers have overhauled 14 turbines at 10 different stations. No particular pattern has been followed in selecting a unit to overhaul, but emphasis has been placed on those with the most operating hours.

Normally, it takes a maintenance crew, which consists of six men and a foreman, 20 working days to overhaul one of the turbines, working an 8-hr day. Most of the crews work a straight 10-day shift, taking 4 days off at a stretch rather than the usual 2-day weekend.

In an emergency, however, the maintenance men have completely overhauled a turbine in as short a time as 5 days, by working around the clock in two 12-hr shifts.

Such an incident occurred recently when one of the blades on a turbine wheel failed during operations at the company's Pecos River station in West Texas. The workers had the unit back in operation just 5 days after the mishap occurred.

A close check of the turbines so far inspected has revealed no particular pattern of defects resulting from normal operations.

Inspection Procedure

Generally, here is the procedure that El Paso Natural maintenance crews follow in tearing down one of the turbines for the purpose of inspection and general overhaul.

The company's Florida No. 2 turbine, for example, was removed from service in April, 1955, after having amassed 13,912 hr of fired time. Purpose of dismantling it was to inspect all individual parts.

This inspection, at the time, was the fourth of its type performed by El Paso Natural Gas Company and, in keeping with the previous inspections, an attempt was made to record the exact condition in which the parts were found in order to establish a fund of information to serve as a basis for a sound maintenance program.

Photographs were used extensively to help describe conditions.

A performance test was run on the machine prior to, and immediately after, the overhaul. The performance tests were studied with regard to the condition of the critical components found in the machine in order more fully to understand tests that will be run in the future for the purpose of pinpointing turbine trouble. Savings in maintenance should then result when

AIR WASHERS and regenerators at Hueco station are visible in this photograph. The brick control room also is shown. The Hueco station was placed in operation in 1953.

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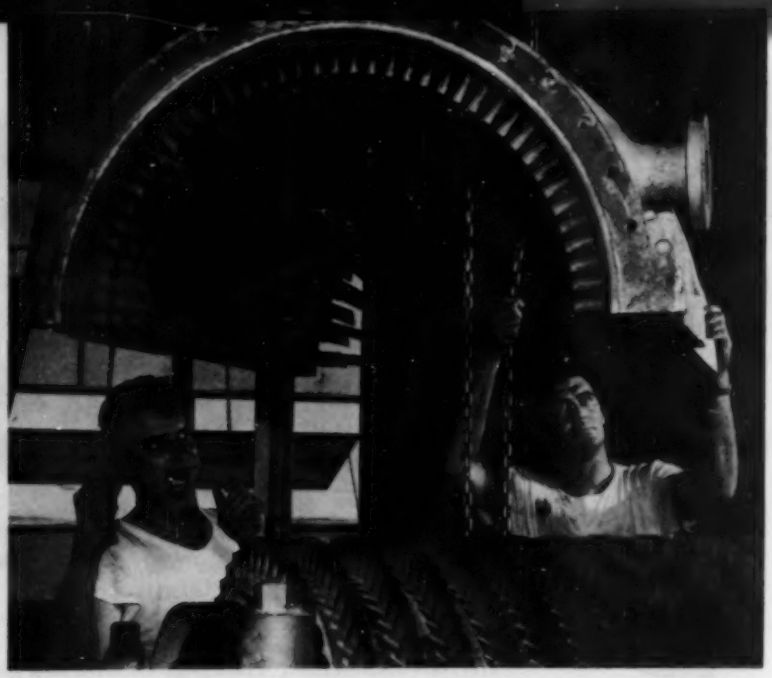
troubles are easily located.

Following is a list of the operations and sub-inspections performed during the inspection of Florida No. 2 turbine.

1. All piping was removed from the unit and inspected for cleanliness or fouling or corrosion.
2. All O-rings, gaskets, etc., were inspected and renewed after cleaning sealing surfaces and reapplying sealing compounds, or O-ring lubricant.
3. All components were marked during disassembly for reassembly in their same position.
4. Clearances of all moving parts were recorded during disassembly for reference during reassembly.
5. Bearings and seals were inspected for wear and all clearances were recorded.
6. Clearance checks were made of the axial compressor blading. Blading was inspected for fouling and wear.
7. Red-dye check was made on the inlet guide vanes and first-stage rotor blading of the axial flow compressor in compliance with recommendation of the General Electric Company concerning failure of a blade in another of their customer's turbines.
8. Turbine buckets of both first and second-stage wheels were removed and red-dye checked for cracks.
9. A sonic test was made on welds of both wheels. The test showed a better than average weld on the second-stage wheel and a border-line condition weld on the first-stage wheel.
10. Red-dye check of both turbine wheels was made, and it revealed cracking in first-stage wheel at the "pine-tree section" where the blade dovetails into the wheel, resulting in its rejection.
11. The first-stage nozzle segments, first-stage shroud segments, intermediate shroud segments, second-stage nozzle partitions, and outer shroud segments were removed from the shell halves, and the halves were hydrostatically tested for water leaks.



MAINTENANCE WORKERS examine an axial flow compressor that has been dismantled for inspection.

12. The outer shroud segments were checked for warpage with a profile gage, and corrected when necessary.
13. The second-stage variable nozzle partitions were red-dye checked for cracks and none was found.
14. All combustion system components were checked for broken pieces, concentricity, corrosion, warpage, and carbon build-up.
15. Vibration and temperature readings were recorded for the machine before and after the inspection.
16. A performance test was made before and after the inspection.
17. Alignment checks were made between the front-end and load-end coupling and corrected when needed.
18. The pressure switches for the various devices were checked during the inspection and reset when necessary.
19. The lubricating oil tank was emptied and an inspection was made of the tank.The oil was filtered during removal from the tank, and again when it was replaced.
20. The exhaust hood was inspected for broken vanes, warpage, etc.
21. The regenerator was checked for cracks in the shell and tube sheet.
22. The flexible couplings were inspected for wear and galling.
23. The gear box was inspected for backlash, thrust clearance, and wear.
24. The pressure ratio valve, gas control valve, nozzle regulator, and load set overspeed valve and trip assembly were disassembled, inspected, and reassembled with new O-rings.

The maintenance crews will next disassemble for inspection a turbine at its Vail station near Tucson, Arizona. Inspection of the latter unit will make the fifteenth that the crews have dismantled.

Plans are to tear down, eventually, each of the remaining turbine units not yet inspected, over a period of the next few months, for the purpose of determining the mechanical condition of each.

Results of Program

In conclusion, it might be said that the gas turbine-driven centrifugal compressor units, although new in design, are taking their place in the industry as a means of pumping natural gas for great distances through transmission lines.

As of this date, from an operational viewpoint, El Paso Natural Gas Company has experienced only minor troubles with the units, such as the failure of some parts that was not expected.

Overall though, performance of the units has been satisfactory; and, with experience gained from more than 3 years' operations, the company feels it can inaugurate a preventive maintenance program that undoubtedly will increase the efficiency of operation.

In the final analysis, it might be said that engineering data collected on the gas turbine-driven centrifugal compressors during the next 12 months' operations will give El Paso Natural engineers an opportunity to draw more definite conclusions regarding the maintenance and operating costs of the units. ★ ★ ★

The Author

E. A. Walsh, division engineer of El Paso Natural Gas Company's Southern Division, attended New Mexico A&M College at Las Cruces, New Mexico, graduating with a BS degree in mechanical engineering in 1949. He joined El Paso Natural the same year as a junior engineer. Walsh has been in charge of operational engineering on El Paso Natural Gas Company's gas turbine plants since they were installed in 1952.

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SEPARATOR
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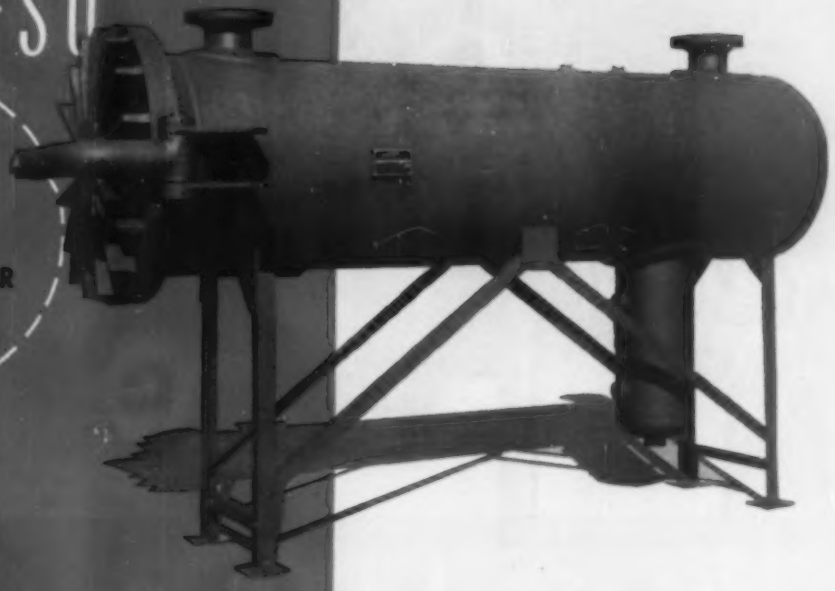

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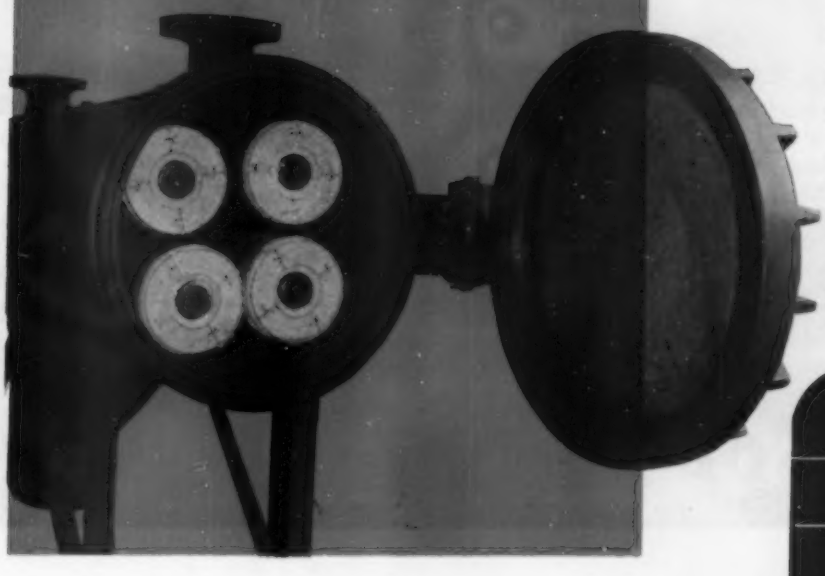

The HP-700 is rated from 750 to 1000 GPM on gasoline and fuel oil. The four repack cartridges provide a total filtering area of approximately 5,500 square inches. This Separator-Filter effectively removes solid particles down to forty microns in size. Equipped with quick opening closures and other easy service features, this compact unit is designed especially for the pipeline industry. Write for detailed information.

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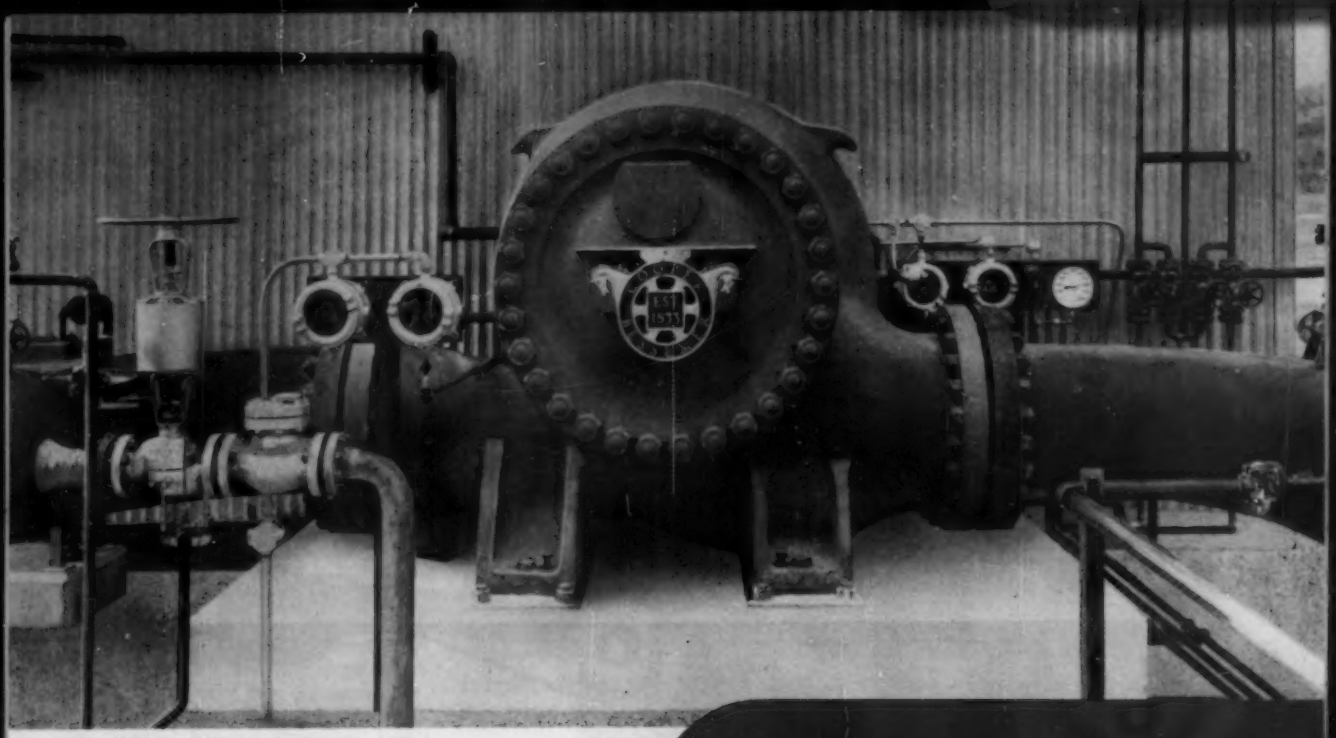
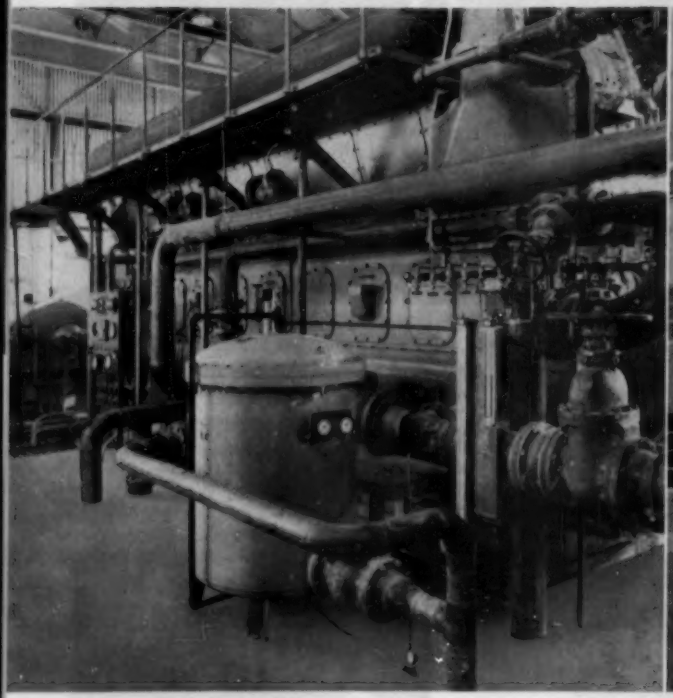


Cooper-Bessemer centrifugal compressor and 4-cycle gas engine, separated by fire wall, comprise unitized set-up in Gulf Interstate's new satellite station. Nominal capacity: 400 million cubic feet a day at 935 psi. Note compactness of station in view at lower right.

Cooper-Bessemer



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PROVED COMPONENT DESIGN . . . Actually the engine and other major components of this unitized set-up are *not new*. They are fully proved designs! It is the *combination* that sets an important precedent and brings new advantages!

Cooper-Bessemer engine-driven centrifugals offer identical or similar gains in various types of service. Additional installations are already under way. Why not discuss *your* plans with the nearest Cooper-Bessemer office?

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Main-line pumping units and shelter at El Paso, Texas, station.

EXCLUSIVE

Southern Pacific system pumps from El Paso, Texas, and Watson, California, to Phoenix, Arizona, with take-offs en route

Simplicity and Efficiency Highlight Products Stations

Jerry Stumm
Pacific Coast Editor

EXACTLY 308 days from the initiation of planning and designing of Southern Pacific Pipe Line Company's Texas-California products pipe line, the first section went on stream between El Paso, Texas, and Phoenix, Arizona. This was on January 3. On January 22, the first slug of gasoline (47,500 bbl for Standard Oil of California) reached Phoenix from the eastern terminus of the pipe line at El Paso. The balance of the 847-mile line was completed and in operation by February 6, and the first gasoline (40,000 bbl belonging to General Petroleum Corporation) reached Phoenix on February 22 from the western end of the line, which originates at Watson, Cailfornia.

Design and construction of the line was under the direction of Engineering Management, Inc., Los Angeles, California. Built for Southern Pacific Pipe Lines, Inc., a wholly owned subsidiary of Southern Pacific Company, the line represents the first common carrier products pipe line ever to be constructed by a railroad on its own right-of-way.

Management and supervision of the new Southern Pacific subsidiary is under the direction of Frank E. Kalbaugh, general manager, and Byron K. Smith, assistant general manager.

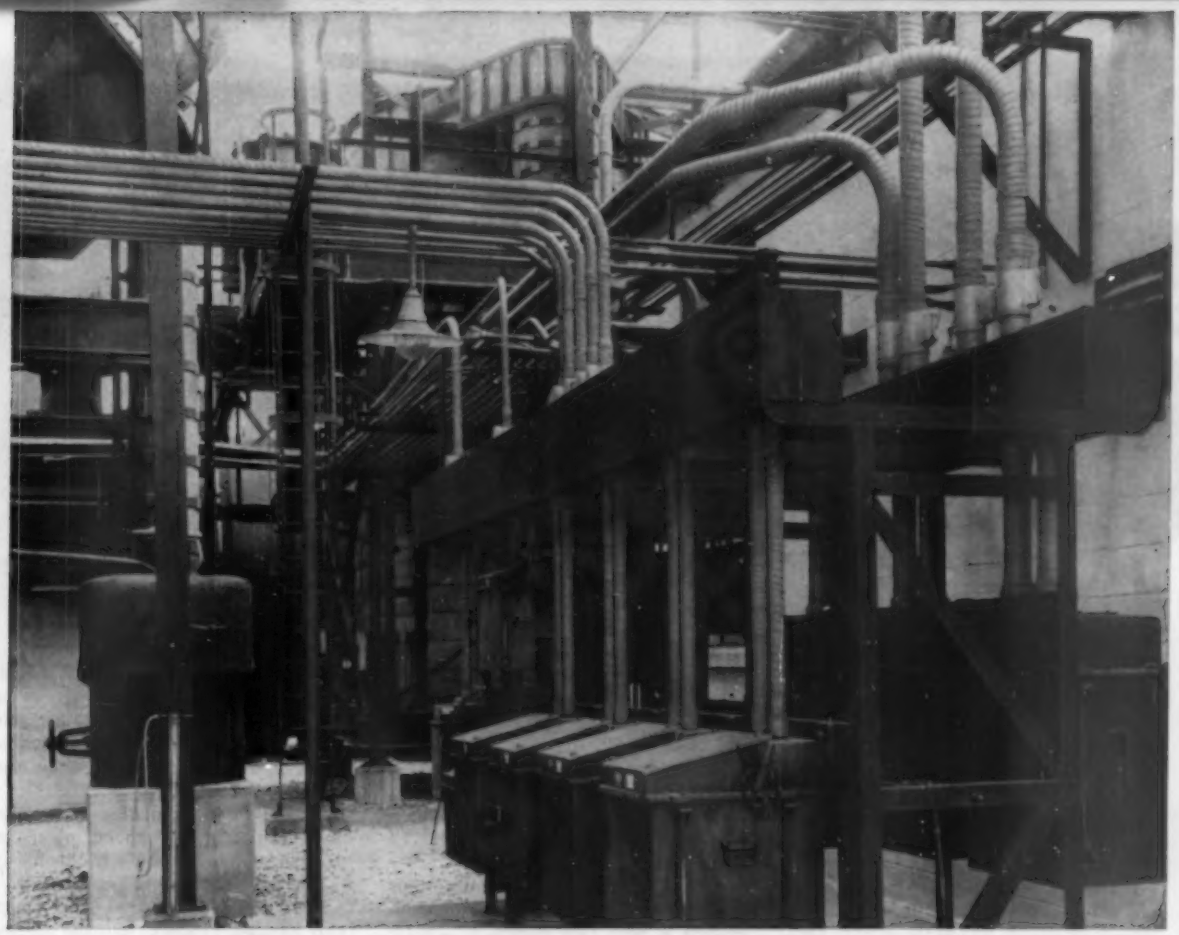
The system is divided into two sections, one delivering products from Watson to Colton, Niland and Phoenix, and the other delivering products from El Paso to Tucson and Phoenix. Main-line sizes are 16-in. from Watson to Colton, 12-in. from Colton to Phoenix, and 8-in. from El Paso to Phoenix.

Watson Station

Watson Station is equipped for receiving products from shippers, either directly into the main-line pump suction manifold or into storage tanks. When shipping products that have been received into storage tanks, the products are moved to the station receiving manifold by tank farm booster pumps, consisting of two 8-in. by 10-in. by 18-in. 4-stage vertical centrifugals capable of delivering 1200 gpm each. These pumps are driven by two 75 hp, 1800-rpm induction motors.

A single-suction line leads from the

Control console and station annunciator panel.



Polyken® protective coating beats corrosion in this sulphuric acid plant

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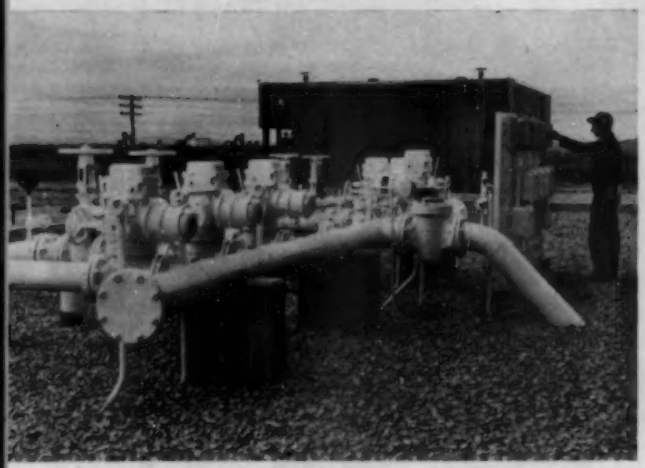


Intake manifold and maintenance building at El Paso.

Booster pumps and manifold for transferring products from tankage to suction of main-line pumps.

receiving manifold to the "hay tank" filter header, and only one product can be handled at any one time. The hay tank installation consists of three 36-in. diam by 9-ft long, 750-gpm units mounted in parallel with a by-pass connection. Next in line is the metering installation consisting of three 8-in. 1300-gpm displacement meters, equipped with dual ticket printers with counter shifters and mounted in parallel with a take-off to the prover tank on the downstream side of the meters. Discharge from the station product sump pump is returned to the suction line at a connection just downstream from the meters.

A single-suction line leads from the meter installation to the pump manifold. A dye pot for coloring batch markers is connected into the line just ahead of the pumps and the inhibitor injection connection is made just ahead of the meters.

The outgoing main line is equipped with a sending scraper trap, station check valve, block valve, and insulating flange. Main-line pressure control valve consists of a 12-in. 600-lb, 30 to 600-psi controlled range valve operated by a dual selector-type pressure recording controller connected to the incoming suction line and discharge line of the station. This arrangement automatically prevents the possibility of exceeding legal allowable line pressure.

A somewhat unusual feature has been provided at the intake side of the station. Here, the shipper delivers his products directly into the suction of the main-line pumps at full station pumping rate, so that it is not necessary to rehandle products through station tankage and booster pumps. This operation requires close timing and coordination between dispatchers at the refineries and the pipe line station, but is achieving very satisfactory results. The switching is done by motor-operated valves controlled from a console in the operators room in the control station. All products are handled through meters, thereby eliminating manual tank gaging and minimizing personnel. The same system is provided at the receiving manifold of the El Paso station.

There are three main station pumps connected in parallel, and normal operation is with two pumps in service and one acting as stand-by. The main-line units consist of centrifugal, 4-stage, 4-in. by 6-in. double volute, single-suction pumps having a capacity of 570 gpm each. They are equipped with mechanical seals and bearings and pump-case temperature wells for high-temperature alarms and shut-down controls. The pumps are driven by 300-hp, 2400-v, 60-cycle, 3600-rpm induction motors equipped with bearing temperature wells for high-temperature alarms and shut-down control.

The hay tanks, meters, and pumps are housed in a structural steel pump shelter that contains a manually operated overhead crane. The station control building contains an office, control room, equipment room, and laboratory. The control room houses the instrument panel and alarm signal board, as well as the console on which are mounted the various station controls. The heating and ventilating equipment for the building and the utility and instrument air compressors are situated in the equipment room. The laboratory is provided with work benches and various items of equipment required for testing products.

Colton Station

Colton is a booster pump station as well as a take-off point where products are returned to shippers. The incoming line is equipped with a station insulating flange, block valve, and receiving scraper trap. Three hay tanks are connected in parallel with a by-pass so that all or part of incoming products can be filtered as required.

The take-off installation consists of two positive displacement meters in parallel, either of which is capable of taking full line flow, a prover tank, a product sump with sump pump, which also handles product drainage for the rest of the station, and a distribution manifold through which the products are delivered to the various shippers.

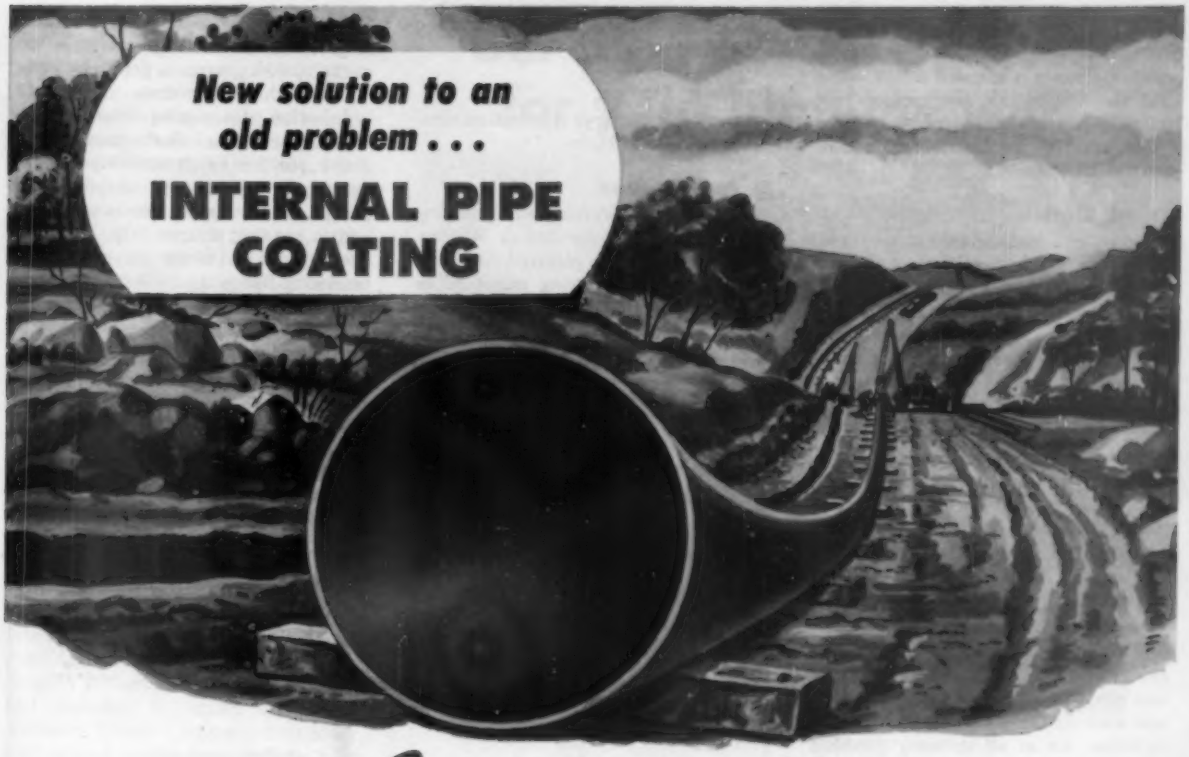
The booster pump installation includes three 5-stage, 6-in. by 8-in. double volute, double-suction centrifugal pumps, each with a capacity of 850 gpm. These pumps are driven by 900-hp induction motors and take suction directly from the main incoming line. Normal operation is two pumps operating in series with one stand-by.

The hay tanks, meters, and pumps are housed in a structural steel shelter identical to the ones at Watson and El Paso. The control house also duplicates the ones at Watson and El Paso, and, in addition, Colton has a station maintenance building, a pipe line maintenance building, and the operational office building for the western division.

Niland Station

Niland is a take-off and scraper-trap station with the main-line installations, including incoming and outgoing insulating flanges, block valves, and scraper traps. The take-off includes one hay tank with by-pass, two displacement meters in parallel, a prover tank, product sump, and a distribution manifold.

The hay tanks and meters are housed in a structural steel meter shelter, and there is a separate control building



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containing an office and equipment storage room. The annunciator and instrument panel is situated in the office and the station air compressors are installed in the equipment room. The motor controls are installed on a concrete slab outdoors.

Yuma Station

Yuma is a maintenance station with provisions for future conversion to a booster pump station. Main-line installations include incoming and outgoing insulating flanges, station-block valves, and scraper traps. The scraper-trap valves are motorized, with power supplied by a local power company.

Horn Station

Horn is a scraper-type station only, with incoming and outgoing insulating flanges, station-block valves, and scraper traps, and a small steel building housing the electrical controls.

Phoenix Station

Phoenix is a terminal station where products from both directions (east and west) are returned to the shippers, and each line is equipped with similar facilities. As at all stations, products are metered out of the system directly into shippers' tanks, eliminating pipe line manual gaging. The line from El Paso has an incoming block valve, insulating flange, and receiving scraper trap. One hay tank with by-pass is installed ahead of the two displacement meters, which are connected in parallel, and the line terminates in a distribution manifold. The usual prover tank and station-product sump are adjacent to the meter installation. The line from Watson provides the same equipment as the line from El Paso, with the exception that there are three displacement meters at Watson, whereas there are two at El Paso.

The hay tanks and meters for both lines are housed in a single, structural-steel meter shelter. The control building is similar to the others, having an office, control room, equipment room, and laboratory.

Tucson Station

Tucson is a take-off and scraper-trap station with installations like those at Niland, except that the control building is similar to those at Watson, Colton, Phoenix, and El Paso, having an office, control room, equipment room, and laboratory.

Lordsburg Station

Lordsburg is a pipe line maintenance and scraper-trap station, with the main-line installations including incoming and outgoing insulating flanges, station-block valves, and scraper traps, with a sump to catch drainage from the scraper traps.

Deming Station

Deming is a scraper trap station similar to the one at Horn.

El Paso Station

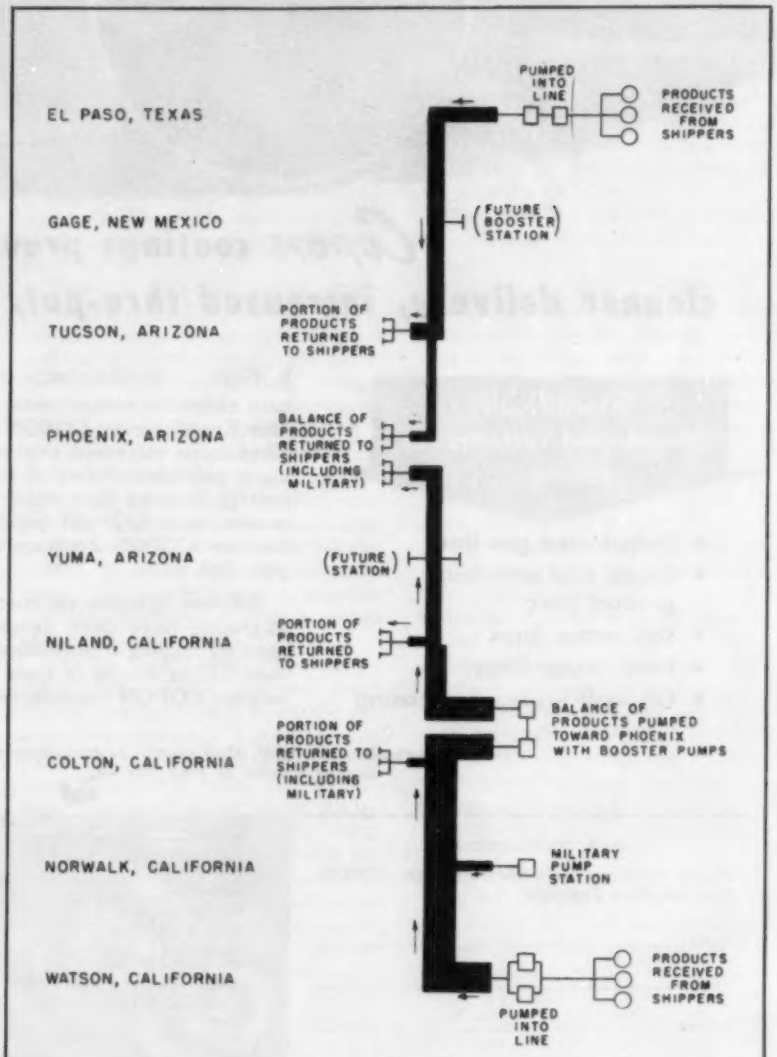
El Paso is a receiving and pumping station similar to the one at Watson, where products are received either directly into the receiving manifold or are received in the tank farm and transferred to the manifold by the tank farm booster pumps. The hay tank, metering, prover tank, and sump installations are similar to those at Watson, except that El Paso has two hay tanks instead of three.

There are three main-line pumps connected in series consisting of 5-stage, 3-in. by 4-in., double volute, single-suction centrifugals, with a capacity of 400 gpm each, driven by three 300-hp induction motors.

Injection of a rust inhibitor solution is made just ahead of the meters, and a dye pot for batch marking is connected into the suction ahead of the pumps. The outgoing line is equipped with a sending scraper trap, a station check valve, a block valve, and an insulating flange.

Tankage

All receiving, delivery storage, and slop tanks are floating roof type. At Watson, there are 3 receiving storage tanks of 55,000, 30,000, and 24,000 bbl, respectively. At Colton, there are 7 delivery storage tanks, 2 of 55,000-bbl capacity, 2 of 25,000-bbl capacity,



System operations diagram.

1 of 30,000-bbl capacity, and 1 of 15,000-bbl capacity. At El Paso, there are 3 receiving storage tanks of 20,000-bbl capacity each.

Tanks at Niland consist of four delivery storage tanks of 15,000, 10,000, 7500, and 5000 bbl respectively. Phoenix has 15 delivery storage tanks in all, comprised of 3 67,000 bbl, 3 30,000 bbl, 1 35,000 bbl, 2 24,000 bbl, 2 20,000 bbl, 1 16,790 bbl, 2 10,000 bbl, and 1 32,900-bbl tank. Also at Phoenix, there are 3 floating roof slops tanks, 1 of 3000-bbl capacity and 2 of 1000-bbl capacity.

At Tucson, there are one 20,000-bbl and 3 16,790-bbl delivery storage tanks.

All products tanks are equipped with automatic gages with visual gage heads mounted near the exterior base of the tanks. Each tank has high-level alarms connected to the alarm panel in the control house.

Electric Power

Electric power is supplied to all stations by utility companies serving the particular areas. Main power transformers and sub-stations were supplied and installed by utility companies. Southern Pacific Company transformers are used to step down voltage from 2400 to 440 v, and to 208/120 v at Watson, Colton, Phoenix, and El Paso for operation of auxiliary electrical equipment, lighting, and controls. All stations have outdoor-type, motor-control centers and switchgear at points remote from the pump shelters and operating areas.

For fire protection, there is a 5000-bbl water storage tank at the Colton, Phoenix, and Tucson stations. To each of these tanks is connected a gasoline engine-driven and an electric motor-driven centrifugal fire pump, each capable of delivering 1000 gpm of water at 115 psi. Fire hydrants at the Watson and El Paso stations are connected to the local municipal water systems. All stations are equipped with portable foam, dry chemical, and CO_2 fire extinguishing equipment.

The line was designed so that its initial capacity can be increased by 50 per cent by the installation of intermediate booster stations. Current daily throughput is 39,000 bbl at Watson, 28,000 bbl at Colton, and 13,000 bbl at El Paso. Products being handled are regular, premium, and aviation gasoline, diesel oil, and jet fuel.

At present, 6-in. laterals are being installed, including pump stations, from Colton to March Air Force Base, and from Phoenix to serve Luke, Williams, and Davis-Monthan air force bases.

* * *

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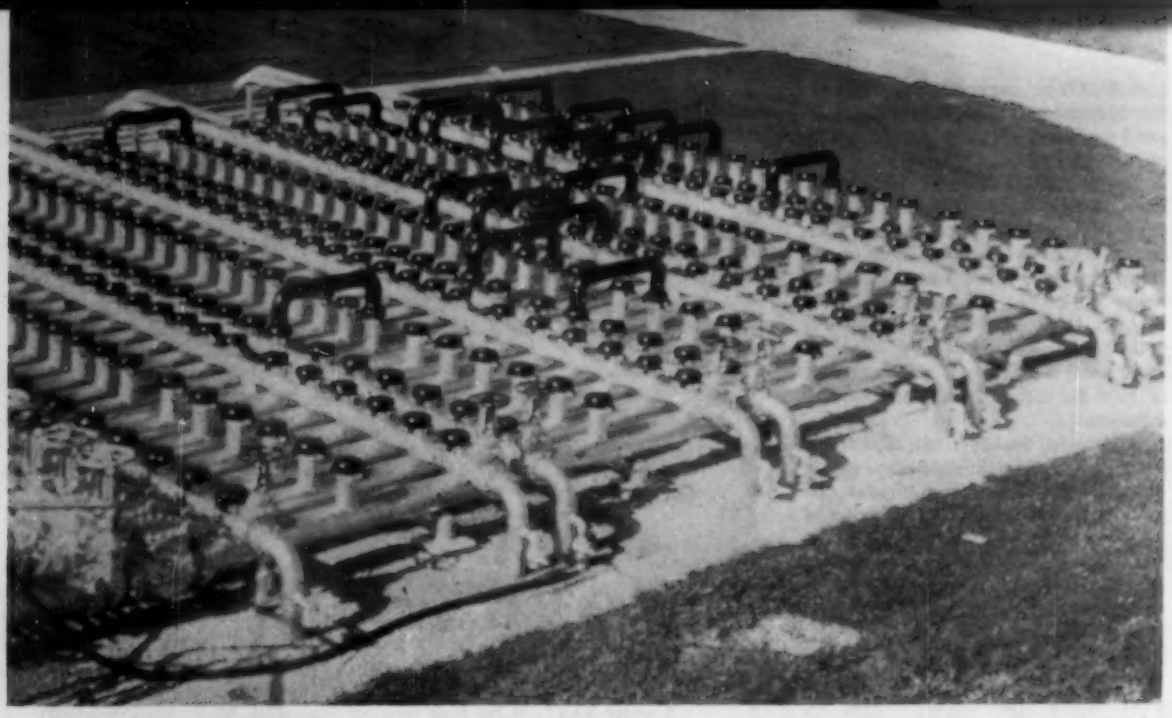

Loading rack manifold. In order to provide flexibility and yet avoid the risk of cross connection leakage, a manifold of this design is used for loading rack service. The lower tier of lines are supply headers from tanks. Any one of these lines may be connected by a loop line to a selected loading line or several such loops may be manifolded to one line.

P 616.93

Products Pipe Line Terminals

. . . in common carrier service

Many factors must be considered in wrapping up the complex operation of a products terminal into a compact, efficient design; here's a report on one company's experiences

C. C. Keane
Chief engineer,
Great Lakes Pipe Line Company,
Kansas City, Missouri

EXCLUSIVE

ONE OF THE FEW POSITIVE STATEments that can be made in regard to common carrier operation of a products pipe line terminal is that rarely can its problems be solved by formula. Our particular experience has been gleaned from these problems, and we make no pretense or claim that our observations are a panacea for the industry as a whole.

What is a products terminal? We visualize it as an aggregation of tanks, pumps, buildings, loading racks, blending facilities, auxiliary equipment, and lots of electrical apparatus. These are all blended into a pattern to provide customers with prompt and efficient service and yet produce a design that is compact, contains adequate control stations, withstand the rigors of weather, has sufficient reserve for peak periods, ample room for expansion, and does not violate local or national safety codes.

An essential factor in terminal location and the determining point around which the whole question revolves is the prognostication of its traffic. A carefully detailed traffic study made by experts in that field will quickly reveal whether the volume is available to justify the investment. The cost to the potential shipper coupled with sufficient earnings to the pipe line to show a reasonable profit are the criteria that dictate decisions. Of course, there may be latent conditions of potential industrial or agricultural expansions in an area that make it mandatory that a terminal location fall in a specified section. Such a situation, naturally, should be given consideration, but it

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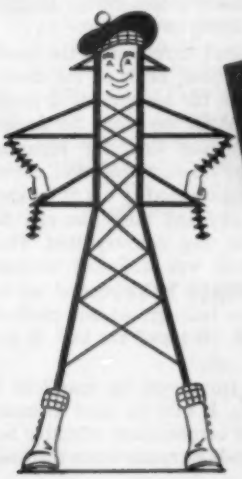

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will be the exception rather than the rule.

Terminal Location

The locale, size, and capacity of a terminal are all important factors, probably the most important being locale. If a terminal is badly placed and competition is within shooting distance, then obviously it will not expand beyond the capacity dictated by convenience and economy. Remember, if the truck and tank carriers cannot transport from the terminal at an economic advantage, competitive sources will quickly stunt the terminal's shipping area.

Locating inside city limits can also produce its quota of headaches. It has been our experience to run afoul of local ordinances, labor problems, fire regulations, and oppressive insurance requirements within the jurisdiction of city zones.

Following the solution of the locality problem is the specific choice of the designated area, and this is important. Again experience can be most useful. Broadly speaking, the site should be adjacent to a network of good trunk highways. It should not fall in areas where subdivisions for home construction are likely to envelope it or restrict its growth. There should be suitable adjoining land for expansion, and, if economically feasible, it is a good policy to option or purchase this this land as insurance for the future.

Establishments such as schools, and particularly cemeteries, are not desirable neighbors where terminals are concerned. The objection to cemeteries stems from the traffic that usually follows funerals; it can quickly block all approach roads to the terminal site.

If railroads are to be a factor, and in certain sections of the country they are vital, then by all means locate the terminal close by and be particular that the railroad is active. An ideal pattern is one where a good railroad serves one side of the property and a hard surfaced truck highway serves the other, both so placed that the truck transports do not have to cross the railroad.

Topography and Drainage

Other quite important factors are topography, drainage, and elevation in relation to watershed or other local flood conditions.

Level terrain is the least expensive to grade. Frequently, so called low-priced land may be purchased, and its eventual cost is doubled by the necessity to haul fill for grading. In these circumstances, money doesn't talk, it whispers. A desirable site topographically is where natural drainage is good and where, if it is necessary to direct water run-off, the cost will fall within a reasonable figure. Sharp aerial photography frequently is quite helpful in studying the meander of dry washes which are not apparent from the ground.

If we seem to give undue emphasis to topography and drainage, it is because first-hand knowledge qualifies us as an expert of sorts in this field. Since the Kansas City flood of 1951, we have been a firm believer in avoiding terminal sites that may inundate, even if the last record of such an occurence dates from Indian legends.

A final factor in choice of site that we have found important is soil stability. If this figure is low and an extensive land stabilizing program is necessary, the cost per acre may quickly climb to unrealistic values.

Tanks full of product load soil to 2500 lb per square foot. Consequently, it is good practice to procure soil that will withstand 3000 lb.

In the agreement to purchase a site, it is a desirable policy to option the property first with a provision that the purchase will be consummated if coring tests are satisfactory. A competent soil analyst or geologist should be retained to supervise the coring and soil loading tests.

Terminal Layout

Now, we should like to take you on an imaginary tour of a Great Lakes terminal, one that includes a pumping station operating on main lines. There will be no attempt to follow any operating sequence; rather, facilities will be pointed out somewhat in the order they might be seen in a walk over the grounds.

The *terminal office* is located in the center of the entrance and egress roads and thus acts as a dividing point between inbound and outbound transport traffic. The building contains work rooms for the clerical staff that handles records of products stock and loading detail. The building also houses a *laboratory*, where such product tests as vapor pressure, octane rating, distillation, color, fire and flash, quantitative lead, and many other chemical analyses are made.

A general exterior view of the pump station shows the nearby *suction manifold* and *hay tank strainers*. Terminal tanks are supplied by individual aboveground lines. These lines also may be used as suction to the main pumps if tankage is to be pumped out. A *receiving line* is never used in loading service because the product must first go to tankage for testing before delivery can be made.

A view of the *loading, receiving, and blending lines* along the main pipe routes and across tank fire walls shows two pipe runs to each tank, for receiving and loading. Formerly, when lead blending also was done at the terminal, there were two lines for this purpose. Incidentally, where loading lines cross beneath concrete driveways, they are *cased in concrete pipe* and *several spare casings* are installed at the time of construction to provide additional approaches in event of expansion or modification.

Vapor recovery lines connect a battery of *cone roof tanks* to an expansion roof unit to form a closed system. These lines operate at 2½ ounces pressure and terminate on the tank top adjacent to the shell. Each line may be closed off at a blast gate to permit operators to remove flame arrestors or to service the vacuum pressure venting assemblies. When full, the expansion roof tanks have a vapor space of 7½ per cent of the liquid volume.

Individual pumps at each tank are used for loading or for delivering to the pump station. The motors are of special design in that they are oil cooled and the oil in turn surrenders its heat to a circulating stream of the product that is being delivered from the bank. The pump impeller is designed to prevent overloading, and the motor may be run indefinitely even though the pump is delivering no liquid. These units are fully weather proofed and were initially used in marine salvage operations 20 to 30 feet below the water surface.

In keeping with the engineering policy of a pump at each tank, *electrical control centers* are designed for outdoor service. The structure houses pump starters and is impervious to all weather conditions except flood.

The starters are readily accessible and may be quickly removed for repair or service. Two starters may be housed in each locker, and the lockers may be placed back to back when required. This system is 440 v, 3 θ, 60 cycle. The power cables are all directly buried to a depth of five feet.

All tank lines terminate at the *loading rack manifold*, heart of the distribution system, for assignment to loading service. At the manifold, the design of an individual line for separate products that characterizes the entire terminal is maintained by use of *jumper loops*, whereby any tank line can be connected to any delivery line. This type manifold was designed because valves could not be depended on to prevent cross leakage. At this particular terminal, 20 tanks are tied in for operation.

Another feature of the manifold is its *flexibility*. It may be used to make any transfer combination effective between any pair of tanks when the lines

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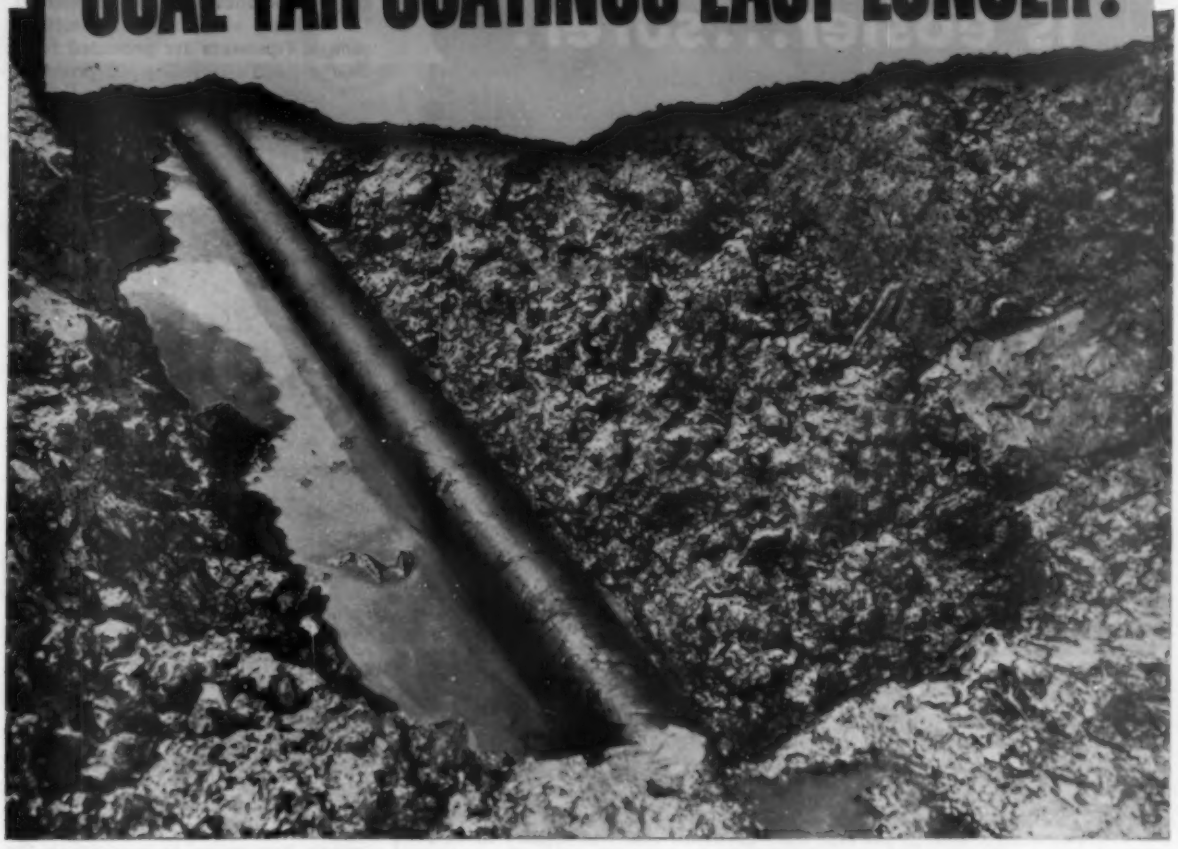

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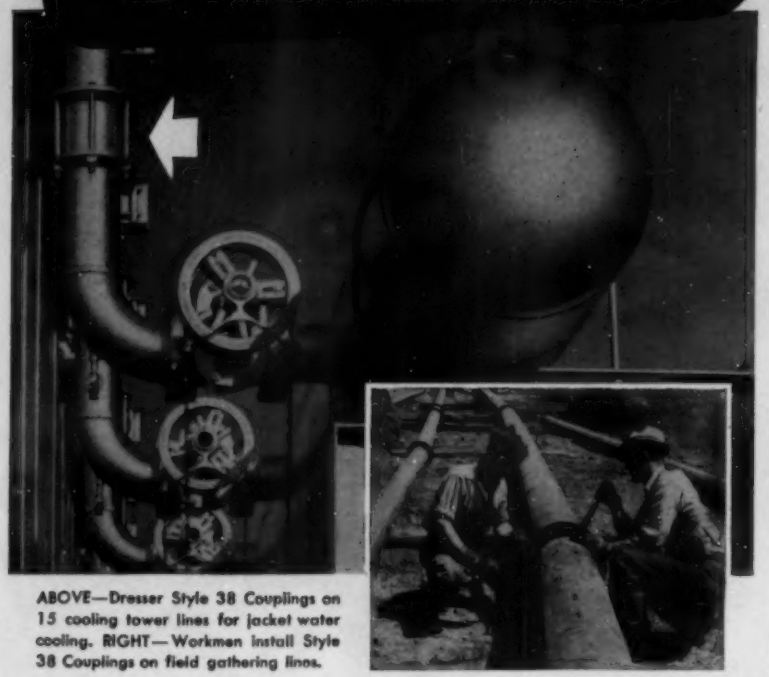

ABOVE—Dresser Style 38 Couplings on 15 cooling tower lines for jacket water cooling. RIGHT—Workmen install Style 38 Couplings on field gathering lines.

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are not in loading service. All tank lines are graded to drain to this point. The transfer feature is used when changing a tank from one product to another.

The *transport truck loading facility* is designed for safety, flexibility, and speed of operation. Nine products are available over the dome run of a truck, and the facilities may be expanded to 12 without any major structural change. Operators are protected from weather, and a *traveling platform* that completely covers the upper section of any truck provides safe walking space. The platform may be push-button adjusted to any elevation within its range of travel. *Push button control* over an electronic system also places tank pump operation at the finger tips of the rack men. In an under structure at ground level, are located the flow meters, control valves, air eliminators, set stop valves, and their associated piping. Feed lines are also at this elevation.

Tank cars may be loaded from either side of a special rack, and as in transport loading, tank pumps are controlled through a single coaxial cable by *electronics calling devices*. Operators work from a hinged platform that lowers from the walkway to a horizontal position. When not in use, *loading swing lines* are secured over *drop cups* to prevent product loss and eliminate the hazard of fire.

Multiple vs. Joint Terminals

This ends the imaginary terminal tour, and, in concluding, we should like to summarize our beliefs. Product terminals for common carrier service, while costly to build, are far less expensive than the accumulated investment of a multiciplicity of small terminals constructed to accomplish the same end. The labor force required is much smaller than the total under the multiple terminal scheme, and pipe line operations are substantially simplified.

It should be remembered that a terminal cannot provide service beyond its design anticipation, or, more important, beyond what the tariff as written permits.

Knowledge Is Essential

In considering a terminal of the type discussed, a studious analysis should be made of the factors outlined at the beginning of this article. Do not forget that a clear-cut knowledge of these requirements is essential and since information alone will not suffice, knowledge should prevail.

The difference between **knowledge** and **information** in our thinking is that knowledge is a precise grasp of all the facts while information may be ill-assorted and encyclopedic, but not necessarily complete and pertinent. ★

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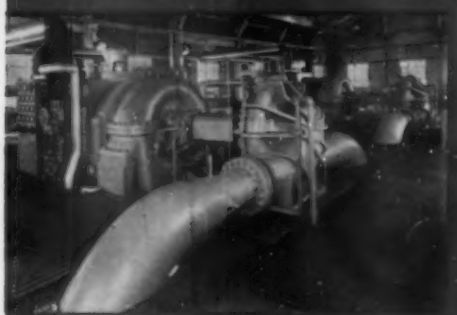

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P 615.635

How Important Are Holidays?

Marshall E. Parker
Consulting Corrosion Engineer
Houston, Texas

How important are holidays in pipe line coating?

It goes without saying that a line that is free from holidays is better than one with holidays, **other things being equal.**

But suppose that other things are not equal? Two coating jobs cannot be compared on the basis of the number of holidays unless they are in every other respect identical—and this means the same coating system, using the same materials, applied in the same thickness. If the coating materials are different, then it is entirely possible that the inherent superiority of one of them may far outweigh even a large number of holidays.

What is a holiday? The term is one borrowed from the painting trade, and technically it means an area—large or small—which was skipped in the application of a coating. It does not cover such other possible defects as poor bond, foreign inclusions, or coating which is of improper composition or which is applied too cold or too hot, unless these defects lead to skipped areas.

As the term is used in pipe line work, however, its meaning is somewhat less specific. Since holidays are usually detected, not by visual inspection, but by the use of a high-voltage "holiday detector," a holiday must be recognized as any point on the coated pipe at which a spark passes.

In other words, a holiday is anything that the detector says is one.

This means that, in addition to areas that were actually skipped in the application, the term also includes some areas in which the coating is too thin; it also includes some (but by no means all) foreign inclusions; and, unfortunately, it must also include some areas in which the coating would have been entirely satisfactory, if it had not been damaged or destroyed by the detector itself.

There are still a large number of gross defects that are *not* included in the definition. In other words, there are quite a number of ways in which coating can be unsatisfactory, and still pass a holiday detector test.

Among these may be listed: **poor bond, inadequate primer, inadequate surface preparation, non-conductive foreign inclusions** (some of these may become conductive later, as they absorb moisture), **and even actual holidays in areas where buckled wrappers increase the total coating thickness to a point beyond the capacity of the detector.**

It is also obvious that a poorly designed, improperly adjusted, or carelessly operated holiday detector can miss all kinds of holidays.

It is quite clear, then, that a holiday detector cannot be depended upon to do the whole job of inspecting coating: first, because it cannot find all the defects which can occur; and, even more important, because the report it gives is not an accurate estimate of the total overall excellence of the coating at all.

How may the total overall excellence of a coating be judged? It is, at the present time, very generally accepted that the coating on a pipe line is one part of the two-part attack that is made upon corrosion, the other part being cathodic protection.

Coating alone is not relied upon to do the job, chiefly because perfect coating cannot be obtained or maintained; cathodic protection cannot be relied upon to do the job alone, because it would be prohibitively expensive.

The excellence of a coating, then, is to be judged by the way in which it cooperates with cathodic protection. This it must do in two ways; it must reduce (by a vary large factor) the amount of current required, as compared with bare pipe; and it must not suffer damage by the application of cathodic protection.

When coating is thus considered in its true role, as a needed adjunct to cathodic protection, then the important quantity involving holidays is not their number, but their **total aggregate area.** This the detector cannot tell us, except in the most general terms.

When two jobs are being compared, on which the same coating materials are being applied, under the same specifications, then a substantial difference in the number of holidays found is a significant indication of a real difference in the quality of the two jobs. But when two different materials are involved in the comparison, the report of the detector, alone, is meaningless and may be very misleading.

This lack of meaning stems directly from the fact that **the detector can only count holidays and cannot measure them.**

Consideration must be given to the physical nature of the two coatings, in order to evaluate the seriousness of single holidays.

How large are they likely to be?

Are they likely to enlarge with time?

Will the application of cathodic protection, or the activities of corrosion, tend to enlarge them?

These questions can only partly be answered from an analysis of coating properties, but certain answers seem to be highly probable.

For example, when plastic tapes are considered as coatings, *the existence of even a large number of holidays is of little or no importance,* **so long as these are not areas of large mechanical damage.** In other words, not all holidays that can only be found by the detector are important.

This follows from the following considerations:

(1) Many such holidays are mere pinholes, of very small area;

(2) Since the coating is not at all brittle, there is little likelihood that they will enlarge with time;

(3) So far as is known at present, neither cathodic protection nor corrosive action will tend to enlarge them.

The pinholes that occasionally occur in plastic tape, and the minute holidays that are created by puncture from small sharp projections on the pipe surface, are almost always so small that they are difficult to see, even after a spark has been passed to locate them. A good guess as to their average diameter would be 0.01 inch.

The area of a circle this size is less than *one millionth* of a square foot—and when it is considered that two milliamperes of current will protect one square foot (although ten or fifteen milliamperes might flow to a single square foot near the drainage point) it is seen that the total effect on the current requirements of a pipe line by even a very large number of such holidays is small indeed.

It is, of course, entirely true that a mile of pipe line covered with plastic tape free from holidays is in better condition than a similar mile with a hundred pinholes—but it is highly doubtful that the difference could be measured by a current requirement test.

And it is certainly **not true** that a mile of pipe line with one kind of coating, free from holidays, is necessarily better than a similar mile **of a different kind of coating** with many holidays.

If all of the holidays are small, then their total effect may be very much less than a difference in the essential qualities of the two coatings. This is not intended to say that plastic tape is therefore better than any other coating; it is intended to say that two different kinds of coating cannot be judged on the basis of the frequency of holidays, but must be evaluated in terms of total performance — and this normally means performance in conjunction with cathodic protection.

In summary, then, the following conclusions can be stated:

(1) The holiday detector can, at best, only perform a part of the job of inspection and evaluating coating.

(2) The number of holidays is not a valid criterion of the excellence of either a coating material or of an application job.

(3) Two different applications can be compared with a detector only if the materials, specifications, and conditions are identical.

(4) When used in conjunction with cathodic protection—as pipe coating usually is—even a large number of small holidays is not very important. ★

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Terminal Station Controlled Remotely

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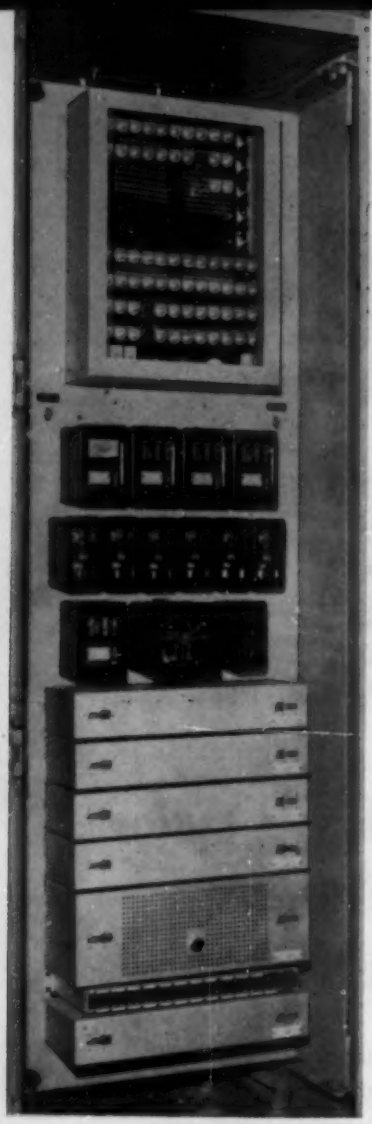
Frank H. Love
Editor, Oil & Gas Pipelining

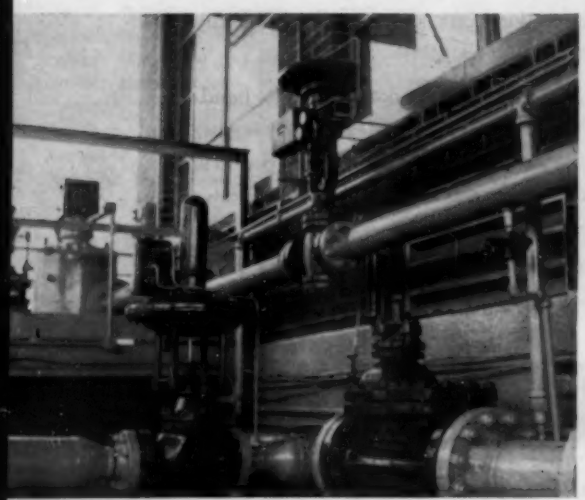


Rome station supervisory control panel.

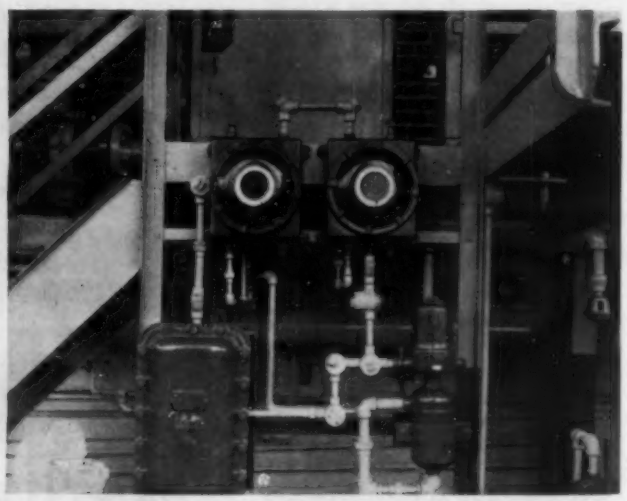
SOUTHEASTERN Pipe Line Company recently installed automatic control equipment that makes possible the remote operation of its Rome, Georgia, station from headquarters in Atlanta 60 miles away. Rome is the only station of 14 on the system to be so equipped and represents something of an experiment.

Remote control of pipe line stations is not a new process, but Rome is a terminal station and there was a question of whether deliveries could be made into customers' tanks successfully when the operation was controlled from a remote point. It had never been tried before insofar as Southeastern officials were aware. The big question was whether the telemetered flow would be accurate as to quantity, and whether the batch products recorder, used to distinguish the product going into a tank, would give the right degree of accuracy at all times. Failure would mean an overflowed tank, the wrong product delivered, or perhaps delivery to the wrong tank. And it must be remembered that the dispatcher is 60 miles from where the delivery is being made. So, as a precaution in the beginning, an operator was always on duty at the station to see that the automatic control equipment functioned properly.

After operating in this manner for a suitable period of time, it was apparent that this concern was unfounded. Remote operation without this operator at



Remote-operated take-off flow control valve is shown at upper center.



Suction and discharge pressure transmitters (upper left and upper right). Batch recorder transmitter and No. 1 pump seal leakage float (lower left and right).

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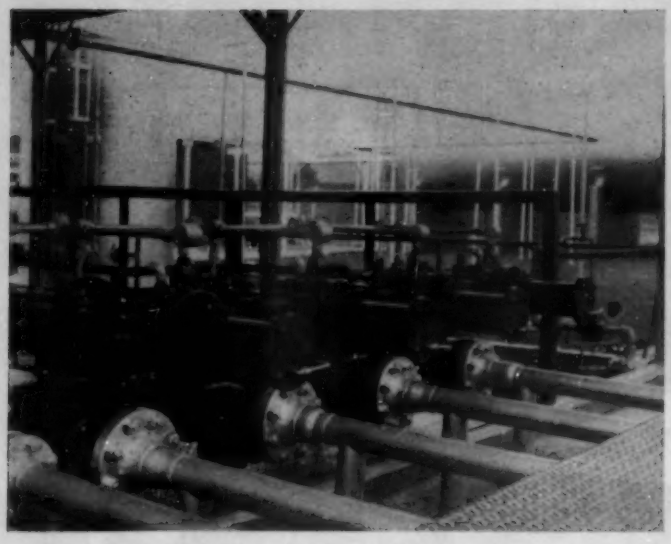

Remote-operated tank farm air cylinder valves.

Dispatcher's control panel in Atlanta office.

the station to check has been entirely satisfactory; but, as an "ace in the hole," a heart cut delivery can be made if there is ever any question as to the accuracy of the batch products recorder. Until now, however, the recorder has proved dependable in every respect.

Before its conversion to complete automatic control, the Rome station was equipped only with conventional controls associated with a semiautomatic pump station. These consisted of protection for low-suction and high-discharge pressures; hot-motor or pump-bearing casing temperature; loss of control air pressure; excessive temperature on motor windings; overload on motors, and reverse phase of motors.

As a result of the changeover, the dispatcher, from his office in Atlanta, can start and stop the two station pumps; control the flow take-off throttle valve to the tank farm; open and close valves that permit delivery of two premium grades and two housebrand grades of gasoline. At present, auto-

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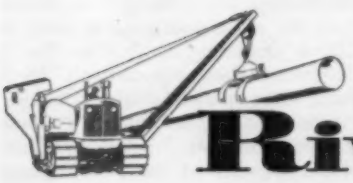

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matic control of fuel oil and kerosine deliveries are not contemplated. This is still done manually.

Additional supervisory control functions include low-suction pressure alarm, high discharge-pressure alarm, an alarm for the automatic fog-foam fire protection system, and a general alarm for hot bearings, hot pump casings, low air pressure, low bearing cooling-water pressure, leaky seals, and combustible atmospheric mixtures in the pump room and manifold pit.

Description of Supervisory Control

The supervisory control, which is an all relay system, operates by transmitting codes of impulses between the dispatching office and the controlled station. A signal consists of a group of impulses, the number of impulses in each group being varied to transmit the desired intelligence. These impulses are transmitted at a rate of approximately 12 to 15 pps from both the dispatching office and the controlled station.

A specific code (called the selection code) is assigned to each function. When the dispatcher pushes a control button for a particular function, the equipment automatically transmits the selection code for that particular device. Relays at the controlled station receive the selection code and set up the control circuits for the selected device. The controlled station then returns a code called a "check" code, a definite check code being assigned to each device. The dispatcher's control unit receives the check code and automatically compares it with the selection code that has been transmitted previously If the selection code and the check code agree, that is proof that the desired device has been selected at the controlled station. When they agree, an operation code is automatically transmitted from the dispatcher's unit. The controlled station receives the operation code, which energizes the proper interposing relay to operate the desired device.

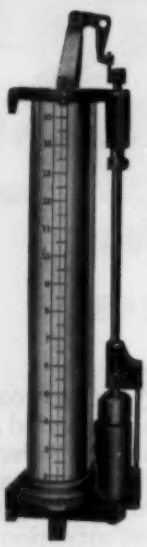
When the device being operated changes position, auxiliary switch contacts on the device cause the equipment to transmit a supervision code to the dispatching office. This causes the dispatcher's control equipment to change the position indicating lamps to correspond to the new position of the device controlled. The dispatching office then automatically transmits a reset signal, which returns the equipment at both the dispatching office and the pump station to the normal "at rest" condition, permitting any other assigned function to be performed when selected.

Audio tone transmitters and receivers for both the dispatching office and the Rome station are used for the operation of the supervisory control equipment. This type equipment also is used to convey the intelligence for operation of four duration-of-impulse type telemetering systems, as well as one spare channel from Rome to Atlanta and one spare channel from Atlanta to Rome.

How Station Is Operated

When a pump is to be started, the "local-remote" switch, situated on the pump station control panel, must be in the "remote" position. The dispatcher then selects the pump, or combination of pumps, to be started by operating either the Position No. 1, or Position No. 2 pushbuttons found on the "pneumatic transfer system" escutcheon.

The pneumatic transfer system (pump selector system) is operated by depressing either of the two control pushbuttons and keeping it depressed until the associated position lamp is lighted. Operating the Position No. 1 pushbutton allows the station's No. 1 pump to be operated singly. Operating Position No. 2 pushbutton will allow the No. 1 and No. 2 pumps to be operated together or the No. 2 pump alone. The No. 1 pump cannot be operated singly under this latter position. If position No. 2 has been selected and



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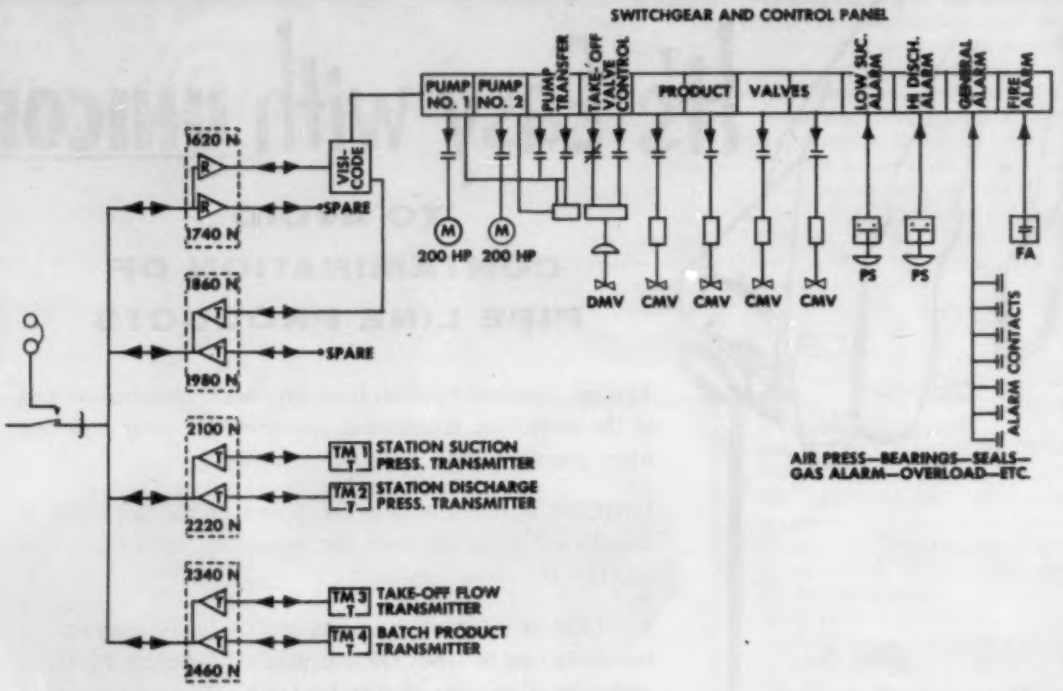
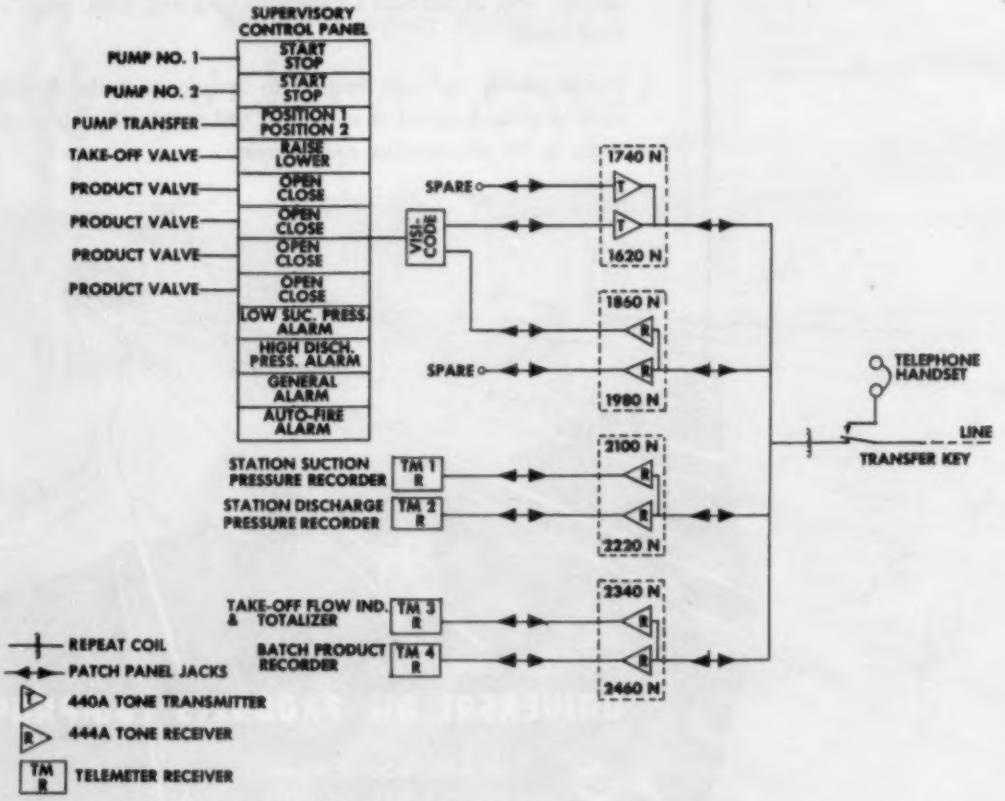


Block diagram of Rome pump station.



Block diagram of the dispatcher's control panel.

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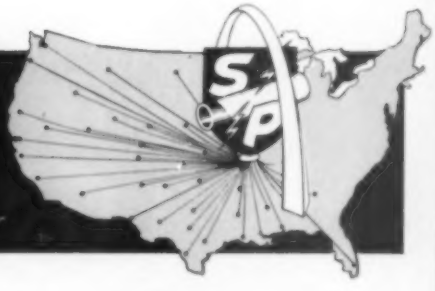

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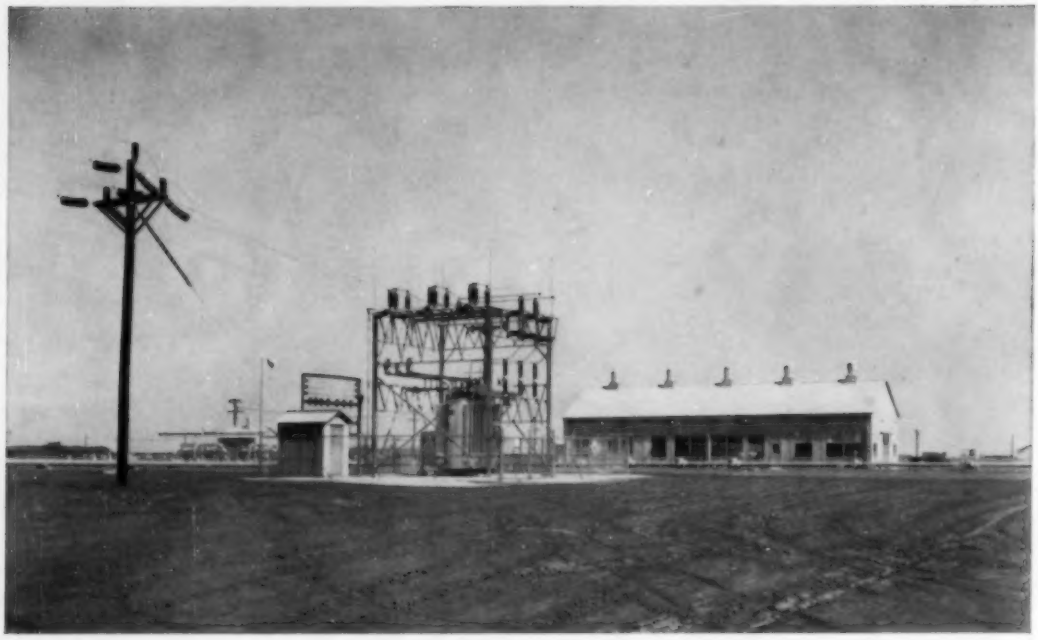

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operation of the No. 1 and 2 pumps is desired, the No. 2 pump must always be started first due to the starting interlock between the two units.

Should the pump selector system change position by action other than by the dispatcher, an audible alarm is given, accompanied by the flashing of the red or green lamp, as the case may be, on the dispatcher's control unit. A non-dispatcher operation of the selector system also will result in the shutting down of the station.

To start or stop a pump after selection is made, the appropriate control pushbutton is depressed until either the amber (running) lamp or the blue (stopped) lamp is lighted. A white lamp, situated between the blue and amber lamps, lights momentarily during either a start or stop operation. This indicates that the proper point to be operated has been selected and verified before the operation is completed.

Starting or stopping of a pump motor by action other than that of the dispatcher causes an alarm to sound, accompanied by the flashing of either the amber (running) or the blue (stopped) lamps in the dispatching office.

Control of Product Valves

Opening or closing of a products tank valve is by means of a pushbutton. No audible or visual alarm, and no flashing of lights, accompanies a change in valve position, however, whether the change is initiated in the dispatching office or the Rome station. The only indication is a change from a steadily burning lamp, amber (open) or blue (closed). Should there be a power or channel failure, either at the dispatching office or at Rome station, any open tank valve will close automatically, and reopen upon restoration of power.

To provide for remote operation of tank farm selector valves, it was necessary to install certain new equipment at the pump station. This equipment consisted of four pneumatically operated cylinder valves and the addition of one electrically operated master valve ahead of the tank manifold.

Rate of take-off flow to the tank farm is regulated by means of a remote, set flow controller that operates a throttle valve in the take-off line. The control index pen is positioned by a reversible gear motor, which is actuated from the dispatching office.

The controlled rate of flow is telemetered to the dispatching office by means of a time-impulse transmitter geared to the counter on the positive displacement meter.

Suction and discharge pressures are telemetered by five-second time duration transmitters.

Product information is telemetered by a five-second time duration transmitter actuated by an electronic capacitance-type instrument. The instrument measures the dielectric constant of the products, and product information is obtained from the differences in the dielectric constants. This equipment is known as the batch detector, the importance of which has been discussed previously.

Channel Supervision

Complete channel supervison of the supervisory control system is provided by transmitting the supervisory tones "On" at each end while the control equipment is at rest, with the impulsing being done by interruption of tone transmission. Normal interruption of the tone control channel due to pulsing will not sound the channel failure alarm. Should a failure occur in the tone control channel in either direction, or should the telephone circuit itself go out, a white channel supervision lamp will be lighted and an audible alarm sounded in the dispatching office. The audible alarm can be silenced but the lamp remains lighted until the complete channel is restored to operating condition.

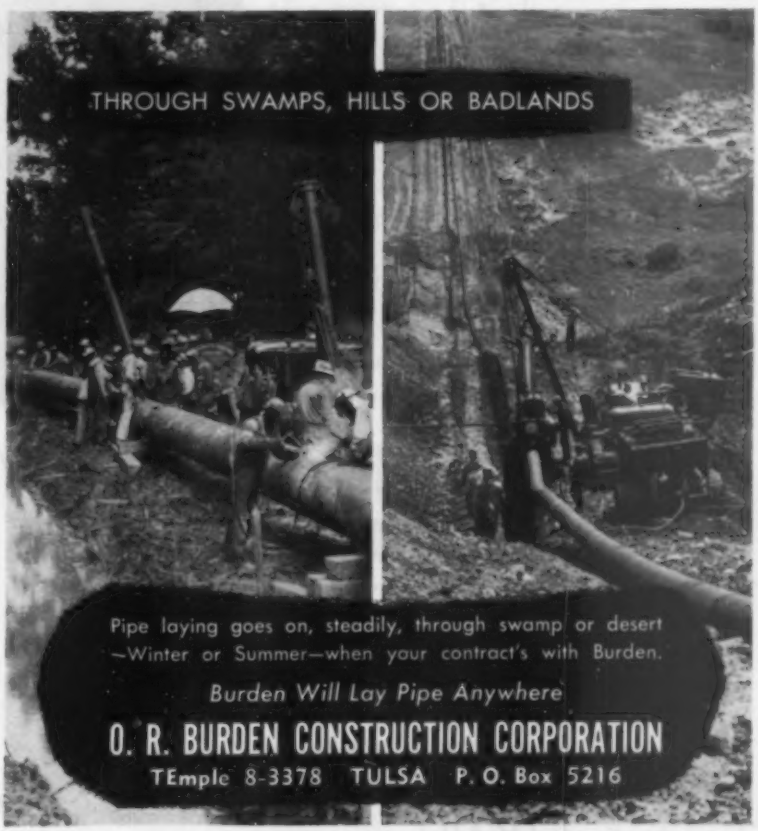
A channel failure of this kind, or the loss of a-c power at either the controlling or controlled end, will result in a complete shutdown of the Rome station. A power failure occurring at the dispatching office will cause a shutdown of Rome station, but no indication will be given due to the loss of power on the dispatching equipment.

When power is restored at either end, or when the telephone tone channels are restored, the position of all devices is automatically reported to the dispatching office, and any change in the position of these devices that took place during a channel or power failure is properly indicated on the dispatcher's control unit.

Failure in one telemetering channel will result only in that particular telemetered function being lost and will not affect any other channel.

Master Check on Equipment

Essential to the successful operation of an automatic system of this kind is the ability to check the operating condition of the equipment involved. This the dispatcher can do from his office. The push of a check button sets in motion equipment that proceeds to select each point of control in turn. If everything is in order, a lamp indicates as much. The dispatcher always makes this master check at the beginning of each shift, and at such other times as he may feel is desirable. ★ ★ ★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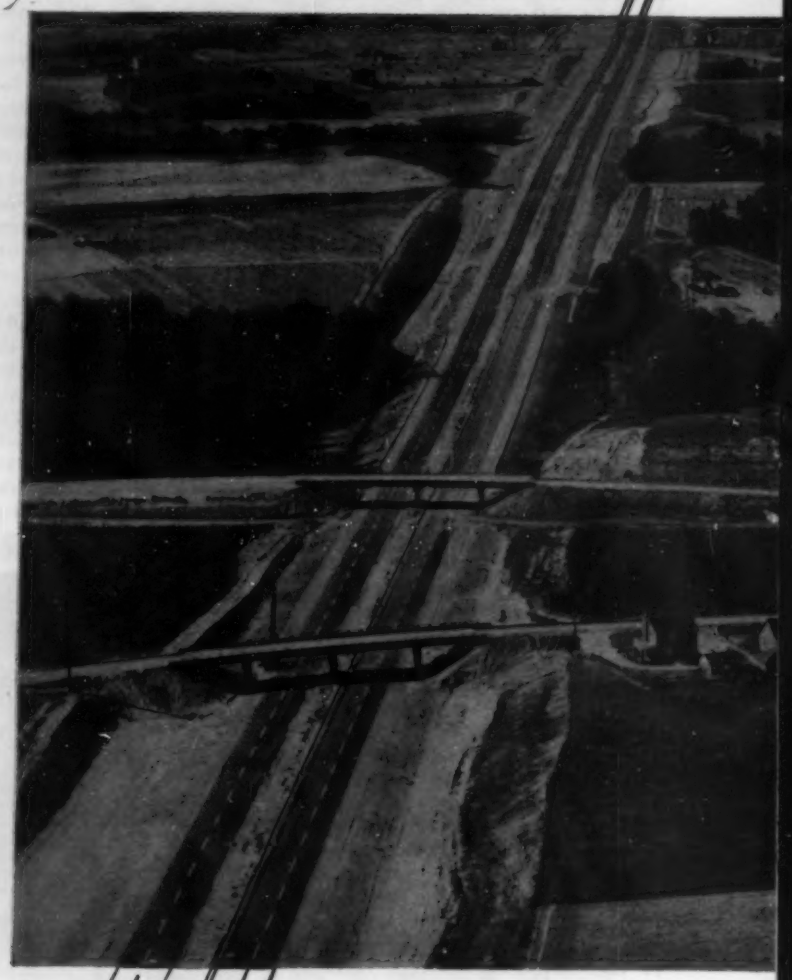

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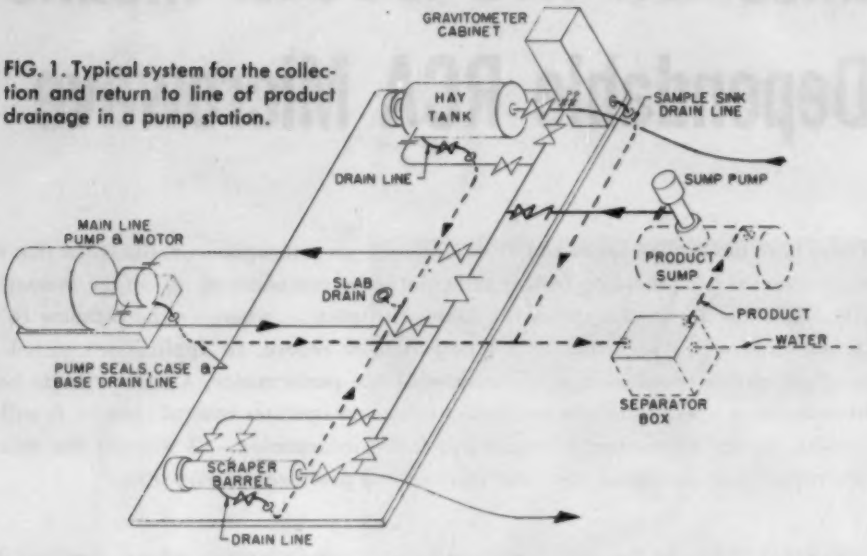

FIG. 1. Typical system for the collection and return to line of product drainage in a pump station.

If proper methods are utilized in operation of closed pipe line system

Loss of Products Can Be Reduced

W. J. Curry
Manager Oil Movements
Pipe Line Department
Shell Oil Company

A "closed system"[1] is a system whereby fluid flows directly from the discharge of one pump through continuous piping connections into the suction of a succeeding pump under proper conditions of pressure and rate control.

Though the closed system is essential to satisfactory operation of a products system for reasons of specification and quality control, it avoids in itself losses inherent in the float or balance tank system where pressure and rate control were maintained by balancing to or supplementing from a storage tank connected to the suction of the downstream pump.

Most products pipe line operators have taken one other major step in the control of losses — the provision of an adequate metering system at both receiving and delivering installations. Though this does not avoid losses incident to evaporation, etc., in emptying and filling of storage tanks, it does isolate or sectionalize the operation, thereby requiring each phase of the operation to stand on its own merit.

As this article considers means of control of losses in closed pipe line systems, no attempt will be made to consider the storage tank problem and control of losses in terminal operation. The reader is referred to the vast amount of literature covering the brilliant and effective work done by the tank manufacturers and petroleum industry representatives on these subjects. Suffice it to say that this isolation or sectionalizing of the problem has doubtless resulted in all branches of the industry becoming more conscious of losses.

Sources of Loss

The principal sources of loss in a closed system are line breaks or ruptures, line leaks as a result of external corrosion, losses at stations through leakage of pump glands or equipment. Other possible sources are drainage of pumps, scraper traps, hay tanks, strainers or filters for purposes of operation or maintenance, and sampling or gravitometer streams for purposes of operational control.

A considerable portion of the effort expended through all phases of pipe line engineering, construction, operation, and maintenance is directed toward the elimination or reduction of these losses.[2]

Engineering

The original design and engineering specifies a line and associated equipment of sufficient capacity and strength to withstand operation at the design pressures with adequate safety factors. Pressure limiting controls are provided as a means of protection against overstressing and possible rupture of the

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The group of anodes produced an average of 33 amps at 36 volts with no tendency to gas block. Actually, the bed resistance has decreased since the original installation. There was considerable cost-saving in the elimination of carbonaceous backfill.

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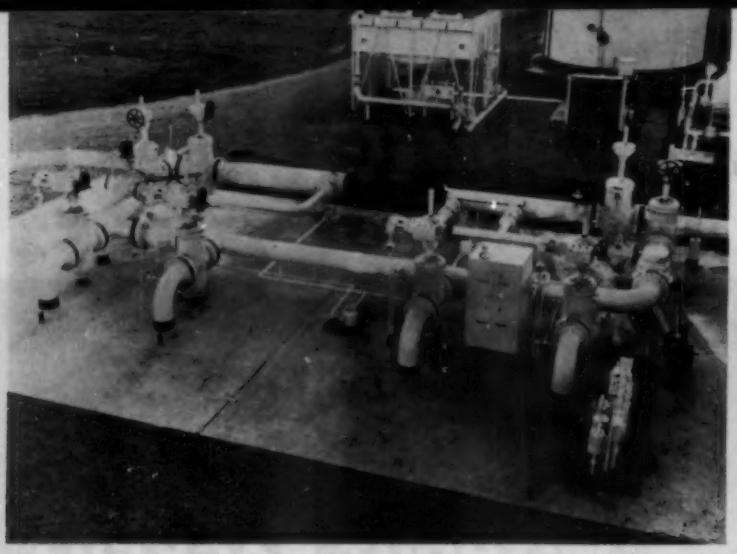

FIG. 2. Equipment drain, collection, and reinjection system at pumping station.

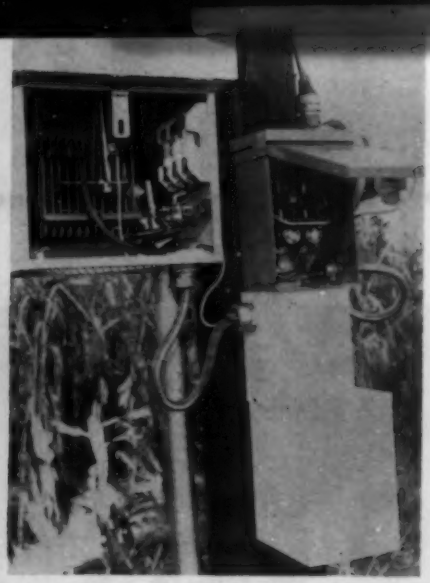

FIG. 3. Rectifier installation for control of external corrosion.

line and/or equipment with attendant hazards and product losses.

Provision is made for the protection of the line against external corrosion, which is potentially one of the major causes of leaks and loss. This protection is achieved by a great number of different methods and techniques either singly or in combination on the basis of soil and electrical surveys. Protection is provided by painting, use of various kinds of coatings, cathodically by rectifier[3], by use of sacrificial magnesium anodes[3], by bonding of crossing or closely associated lines, by insulating flanges, etc.

Main line block valves are installed at strategic locations to isolate and control losses and reduce hazards in the event of a leak or line break.

Catch basins and drains are required at stations or other locations where the operation or maintenance necessitates the removal of fluid from the system. Fluid from these sources is normally collected in a sump and reinjected into the system by means of a pump (see Fig. 1 and 2).

The meters and associated equipment, including calibration or prover facilities, are of major importance since accurate measurement becomes the criterion for the evaluation of losses. The products pipe line industry in general has adopted the use of positive displacement meters. Cooperation between meter manufacturers and industry members has resulted in meters of extreme accuracy and durability. Meters and measuring practices have been improved continually by research and study by these groups. Calibration systems, such as specified in API Code 1101 as promulgated by the ASME and API[4], or alternate methods such as the calibrated pipe line section[5] have been responsible for improved accuracy with ever-increasing control over losses.

The use of mechanical seals on pumps has proved a worthy method of conserving product. Product leakage required through a packed pump gland for proper operation is normally considerably in excess of that experienced with a mechanical seal. Frequently excessive leakage develops on a packed gland, which cannot be eliminated without repacking, as the gland cannot be tightened sufficiently to eliminate excessive leakage without causing overheating of the gland and sleeve and ultimate galling of the shaft. The mechanical seal has reduced the losses from this source and has, in general, a longer service life than is normally realized from packing.

Construction

Strict adherence to proven engineering design criteria and avoidance of deviation from these standards in the construction of a line and attendant facilities, plus proper inspection, should result in a system that provides maximum physical insurance against losses.

The methods described in API Bulletin 1105, "Bulletin on Construction Practices for Oil and Products Pipe Lines," should be followed insofar as practicable. These practices represent the consensus of the experts in this field of endeavor. In addition to being meritorious for many reasons other than conservation, a number of these practices are of paramount importance in the control and reduction of losses.

Upon completion of construction, the line and facilities are normally hydrostatically tested to some reasonable pressure above the expected operating pressure. When possible, this is accomplished in successive sections using water as the test media.

Operation and Maintenance

Continual vigilance and close attention to a myriad of minor operating details is the price of conservation.

As measurement is the basis for evaluation of losses, it is the responsibility of the operating and maintenance groups to have meters properly maintained and see that they are calibrated with sufficient frequency to insure the required accuracy.

Accurate accounting, which requires proper charge and credit for any product entering or removed from the system, is essential. Meters should be required at any location where product is removed for own consumption at plant facilities.

Good housekeeping is essential as it permits detection and requires elimination of leaks, drips, seeps, and weeps, which result in large savings of product in the aggregate. In general, the housekeeping standards of the product pipe line industry have been outstanding.

The occurrence of a substantial leak or break frequently will be evident to station operators by an otherwise unexplainable change in pressure, flow, or power consumption. Alertness for such occurrences with immediate reporting and taking remedial action to isolate the leak section by valve closure can result in an appreciable reduction of loss.

The maintenance of relations and contacts with right-of-way land owners or tenants whereby they advise pipe line personnel of the existence of leaks has proved effective in minimizing losses. The payment of modest sums as a token of appreciation for the reporting of a leak by right-of-way neighbors has served to increase the incentive and has been an effective adjunct to this relationship. In addition, the pub-

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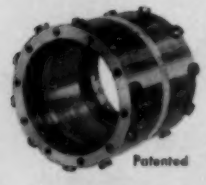

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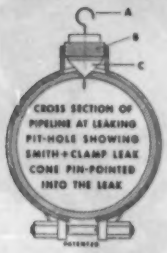

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lic relations aspects of such a program are invaluable.[6]

Frequent attention to the external corrosion protection systems is essential. This involves inspection and maintenance of the rectifier systems to insure their continuous proper operation[7] (see Fig. 3). It involves periodic testing and replacement of the magnesium anodes where necessary. It may require repair of existing coatings or the coating of additional sections as conditions indicate to be necessary.

Line patrol either by airplane or line walker frequently reveals conditions that preventive maintenance can keep from becoming leaks or source of loss.

Adequate protection of line valves and unattended installations should be undertaken by enclosure, fencing, locking, and sealing against pilferage or unauthorized access.

The Author

W. J. Curry is manager, oil movements, of the Pipe Line Department of Shell Oil Company.

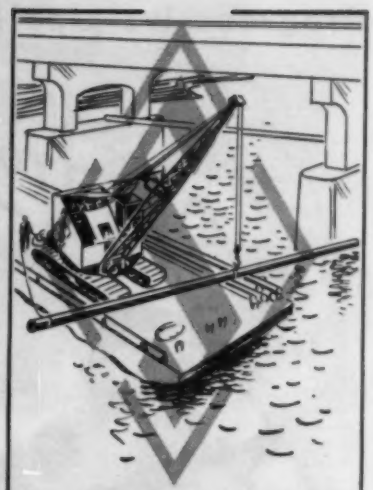
After graduation from the Colorado School of Mines, with a degree of petroleum engineer, he spent several years in the Manufacturing Department of Shell at the former East Chicago refinery.

Transferring to the Products Pipe Line Department in 1939 as chief chemist, he was in charge of laboratories and responsible for product quality control. He was involved with studies on interfacial mixtures in products line operation and in the development of the SCIP process for inhibition of internal corrosion of products lines. He is copatentee of a process for mitigation of corrosion in the cargo compartments of tankers in products service.

Curry became chief dispatcher in 1947 and held that position until his present assignment in January, 1956.

Dispatching and Accounting

The dispatching and operating accounting records maintained on an hourly basis provide one of the most important safeguards against excessive losses. Most pipe lines appear to prefer the correction of received and delivered volume to a 60 F basis hourly as a means of dispatching and accounting control. The dispatcher maintains an hourly log of receipts to and deliveries from the line. From these figures, he calculates the over or short position and maintains these records on an hourly



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and 24-hr cumulative basis covering the accounting day.

Although both hourly and cumulative line balance figures are subject to considerable variation due to pressure, temperature, or coefficient of expansion of product entering or leaving the line, an indication of other than an extremely small leak is usually apparent from these figures.

Examples of the effects of pressure, temperature, and product being received and delivered are as follows:

1. An increase in pressure in a line will result in an apparent loss of product due to compressibility of the product until the new higher pressure level is established over the entire line. This apparent loss has gone into inventory in the line and will be recovered as a gain when pressures are reduced to their former level.

2. A drop in temperature of product delivered to a line will result in an apparent loss until temperature equilibrium conditions have been re-established along the line.

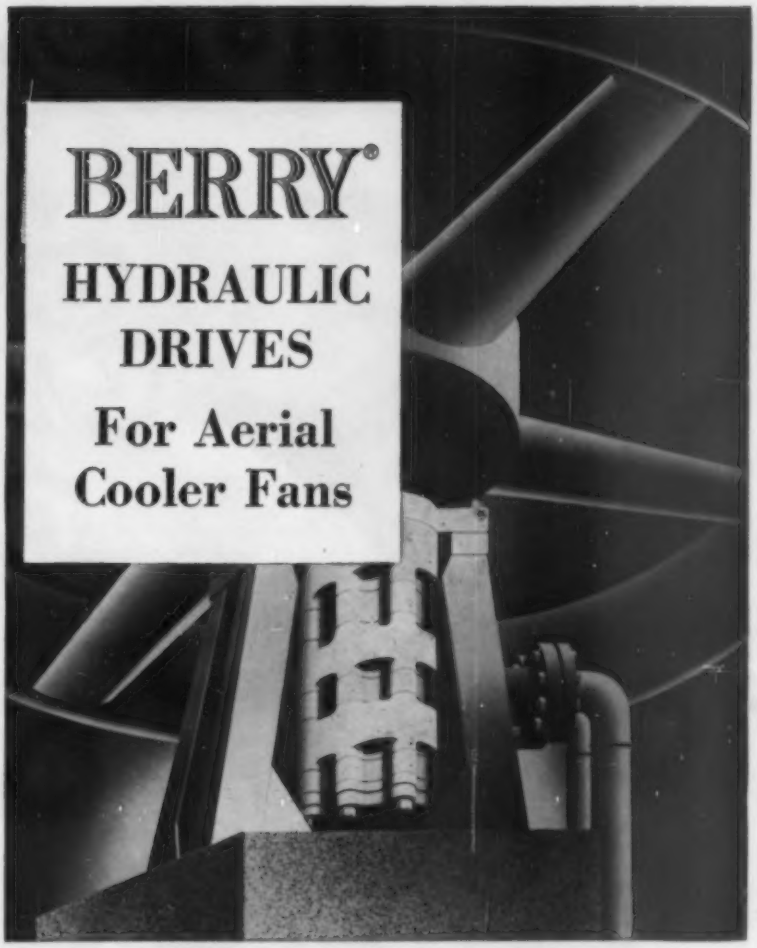
3. Due to differences in coefficient of expansion of different products, an apparent loss or gain is experienced when receiving product of one gravity while delivering product of another gravity at the same temperature. Thus, when both the receiving and delivering temperatures of the line are the same, or nearly so, the coefficient of expansion of various products results in an apparent loss or gain in accordance with Table 1.

As an example of possible apparent losses and gains, Table 2 (based on the abridged table for reduction of volume to 60 F against API gravity at 60 F of ASTM-IP Petroleum Measurement Tables) shows percentage variations due to differential coefficients of expansion of different products. These results are again subject to modification by virtue of temperature conditions along the line as stated in effect (2) above.

As Table 2 is reversible at about 60 F, it may be used for indication of loss or gain when receiving gasoline and delivering distillates by changing the plus signs to minus, and vice versa, or by an inversion of the temperatures.

4. One further effect that should be mentioned is the apparent loss experienced due to the gradual cooling of the line in the fall and early winter. This results in a gradual contraction of product in the line with a corresponding increase in inventory of 60 F corrected barrels. The opposite effect occurs during the warming cycle of the line.

Although the combined effect of the above variations is calculable for any given set of conditions within a reasonable degree of accuracy, it is obvious



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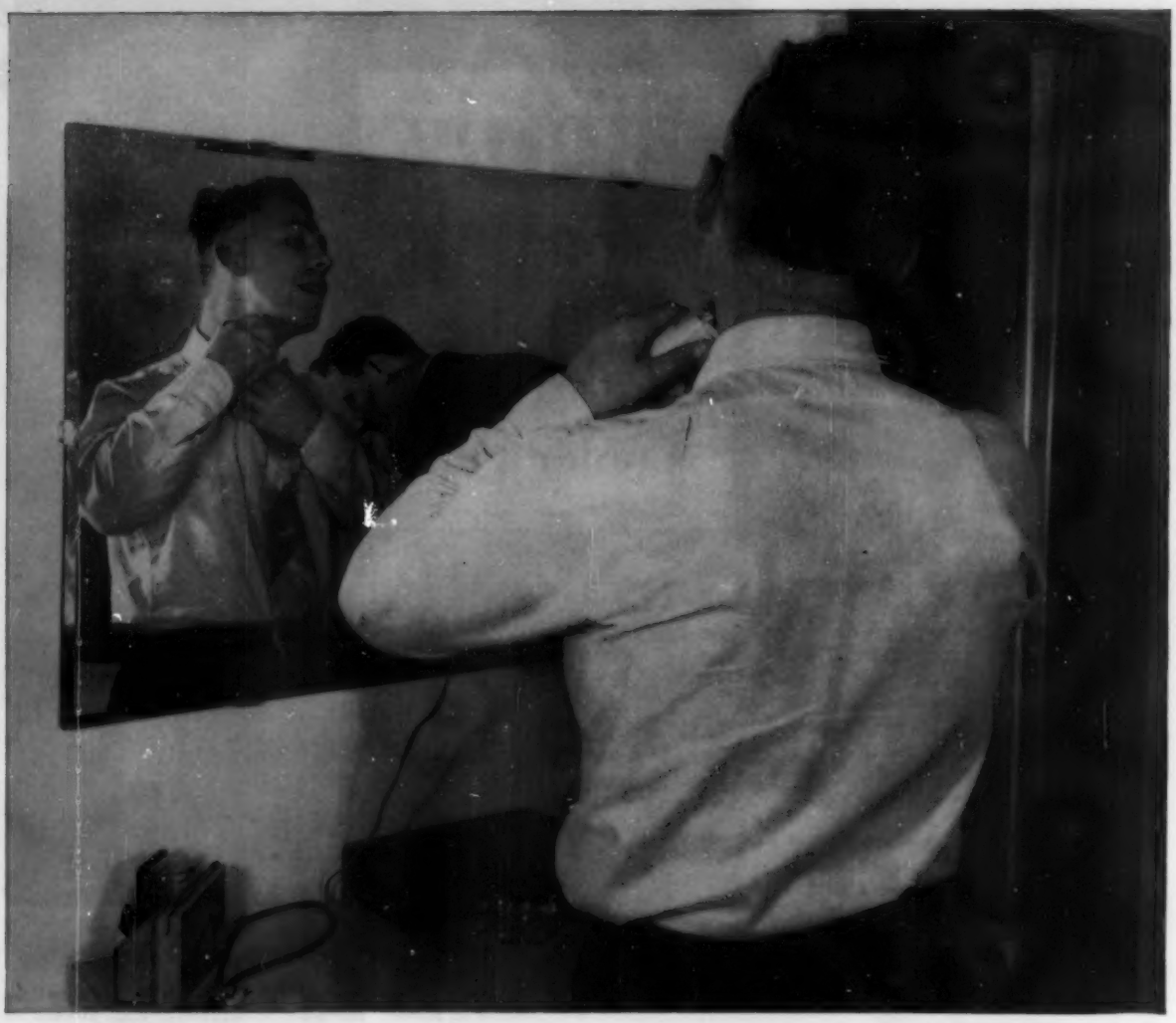

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"That isn't a complicated question. What do you think?"

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Table 1

Temperature of receipts and deliveries	Distillate entering line—gasoline leaving line	Gasoline entering line—distillate leaving line	Same gravity product entering and leaving line
Above 60 F	Loss	Gain	0
60 F	0	0	0
Below 60 F	Gain	Loss	0

Table 2

Apparent losses and gains due to differential coefficients of expansion and temperatures when receiving distillates (Group II) and delivering gasolines (Group III) — Per cent.

Pipe line receiving distillate, temperatures deg. F	Pipe line delivering gasoline, temperatures deg. F				
	40	50	60	70	80
40	+0.22	−0.38	−0.99	−1.61	−2.20
50	+0.71	+0.11	−0.50	−1.11	−1.71
60	+1.21	+0.61	0.00	−0.61	−1.21
70	+1.71	+1.11	+0.50	−0.11	−0.71
80	+2.20	+1.61	+0.99	+0.38	−0.22

that the possible combinations are infinite in number.

One of the best insurances against excessive product losses is a capable and alert dispatcher who, by virtue of experience and his "feel" for the job, can evaluate the combined effect of the above-mentioned factors and determine the probable existence of a leak.

When, from the above welter of facts, a leak is suspected, the dispatcher arranges for a shutdown of the line under pressure. The various sections of the line are isolated by means of valve closures at the stations and pressure readings are taken and tabulated at frequent intervals for each section. In the event of pressure loss in any section indicating a leak, the location of the leak can be isolated further by closure of line block valves with pressure readings within the more narrowly isolated sections. The actual location of the leak is then normally found by a patrol of the line.

Maintenance of batch accounting records provides a further insurance against continuing losses, and when used in conjunction with hourly and cumulative over and short reports, provides a desirable control system.

Batches are debited to the line on a temperature and pressure compensated basis between midpoints of interface on each end. The midpoint interface is determined by midpoint of gravity change, color change, dielectric constant change, or by peak of dye plug radiation[8], etc. Any product delivered from between these two midpoint interfaces is credited to the line and to the appropriate batch. Within the limitations of measurement accuracy, the input and output volumes should agree except for losses. This method provides a more accurate determination of product loss than the line balance method but has the disadvantage of being on a time delay basis.

Summary

The closed system avoids losses inherent in the float tank system.

Accurate measurement is the criterion for evaluation of losses and, therefore, of paramount importance in their control. Segregation of losses permits a better evaluation of the problem and increased effectiveness of remedial measures.

Continual vigilance for conditions that may indicate a leak are mandatory. Effective and rapid remedial measures must be taken in response to these indications.

Frequent inspections with preventive maintenance of potential loss sources must be observed.

Complete cooperation of all personnel involved with the project is essential in the interest of handling products with minimum losses.

Acknowledgment

The author wishes to express appreciation to G. D. Harden for his assistance in the preparation of this paper.

Bibliography

1. "Instrument Application in Products Pipe Line Industry" by Harold R. Hoyt, presented at Petroleum Engineering Conference, ASME Kansas City, Missouri, September 22-24, 1952.
2. "Conservation or Loss," by D. L. Rankin and E. H. Baird, *The Petroleum Engineer*, May 1954.
3. "Pipe Line Leaks Not Inevitable," by Wayne A. Johnson, *The Petroleum Engineer*, Aug. 1953.
4. "Meter Calibration on Products Pipe Lines and Adoption and Use of ASME-API Meter Code 1101," by L. M. Miller and A. R. Dunlop, Sun Pipe Line Company, presented at Products Pipe Line Technology Conference, API Division of Transportation, Fort Worth, Texas, April 21, 1952.
5. "Progress Report on Large Capacity Pipe Line Meter Proving Practices," by R. E. Speckmann and M. L. Barrett, Jr., presented at Products Pipe Line Conference, API Division of Transportation, Philadelphia, Pennsylvania, May 10, 1954.
6. "Case History of a Good Public Relations Job," *The Petroleum Engineer*, April, 1953.
7. "Operation and Maintenance of Pipe Line Cathodic Protection Systems," by Marshall E. Parker, *The Petroleum Engineer*, June, 1952.
8. "Isotopes and Interfaces," by Jerome Kohl and R. A. Newacheck, *The Petroleum Engineer*, March, 1954.

★ ★ ★

Padding machine can be attached to sideboom tractor, backhoe, or dragline.

EXCLUSIVE

P 615.34

NO DIRT HAULING

Rock Ditch Padded from Spoil Bank

A machine for padding ditch in rocky areas without hauling in dirt or employing other means of protecting the pipe is being used on Sinclair Pipe Line Company's 18-in. crude oil line, now under construction between Jacksboro and Teague, Texas. This is the first section of a line that will be extended from the latter point to Houston with 20-in. pipe.

The padding machine is essentially a revolving "grizzly" or screen that revolves in the spoil bank, separating dirt from rock. The head is so designed that it will not allow anything over 2 in. diam to fall into the conveyor tube. Thus a rock of more than 2 in. diam cannot come in contact with the coating or pipe during the padding operation.

The dirt falling through the revolving head drops into a pan and is transferred by an auger drive through a steel tube to a point directly above the pipe. The conveyor tube has four doors in the bottom, and by opening the proper one the padding material falls at the desired point.

The unit is powered by a 50-hp industrial engine, which transmits the power through a torque converter. The torque converter is the safety feature on the unit, inasmuch as it takes the shock when the revolving head comes in contact with a large rock, or some other object equally as hard to move.

Head of unit revolves in spoil bank, rejecting material of more than 2 in. diam. Dirt falls completely around pipe and pads it to depth of 6 in.

At the time of writing the padding machine had been used on approximately 30 miles of Sinclair's line in the vicinity of Fort Worth, on the River Construction Company spread. Through this particular area there is an overabundance of boulders, caliche, and solid limestone. As a result almost 80 per cent of the pipe had to be padded on this 30-mile stretch.

The unit averaged approximately 40 ft of padding a day, which involved placing 6 in. of padding under the pipe, 6 in. on top of the pipe, and in many instances as much as 2 ft of padding on the sides, as ditch that has been shot or backhoed usually is considerably over-width.

The technique being used by Sinclair in padding rock ditch is to lower the pipe in on soft dirt pads, which are space about 40 ft apart. This leaves a space of about 6 in. between the bottom of the ditch and the bottom of the pipe. As the small rock and dirt are tumbled through the auger-type conveyor tube, they flow underneath the pipe in much the same fashion that sand would.

From the contractor's standpoint the unit is quite flexible. Ordinarily the unit would be attached to a sideboom tractor, and to do this an 8-in. wide, 1¼-in. plate, is welded at the bottom of the boom. Ears are welded onto the plate and the boom, which carries the conveyor tube, is installed in much the same way as a sideboom is attached to a tractor. After the plate and ears are once installed, the unit can be mounted on the tractor in a matter of 10 minutes, and can be dismounted by simply knocking the pins out where it is attached to the plate. Thus the contractor can utilize his tractor for other operations when the ditch is such that padding is not required.

The padding machine also can be mounted on a ½-yd backhoe or a ½-yd dragline if desired.

Regarding the economics of its use: The cost is approximately 10 cents a ft; hauling in dirt can run to 50 or 60 cents a ft, depending on circumstances.

M. J. Crose Manufacturing Company, Tulsa, Oklahoma, is the designer and manufacturer of the equipment. ★ ★ ★

Microwave System Mileages, Technology Continue to Grow

Dean Hale *Technical Editor*

PIPE line microwave systems continue to grow, according to the latest annual microwave survey conducted by The Petroleum Engineer. In the past 12 months, over 2000 miles of microwave circuits have been built, contracted, or are under construction. These additions, plus the more than 15,000 miles already in service, add up to a tremendous network of over 17,000 miles of microwave circuits operated by U. S. pipe line companies.

This figure becomes even more impressive when the channeling of these circuits is included—channels in operation ranging from one up to 85 per system.

Stations built, contracted, or under construction during the past 12 months total 111, which, added to the 584 already in service, add up to nearly 700 stations.

In the planning or bidding stations, according to the survey, are some 2500 miles of microwave circuits and nearly 100 stations. The survey includes all known systems in operation, those under construction and information available on proposed facilities.

A 2-Color Map Showing the Location of U.S. Pipe Line Microwave Systems Is Included As a Separate Supplement in This Issue for Your Information.

Latest Additions

Largest system added to the list in the past year is the 760-mile, 29-station system between Ponca City, Oklahoma and Houston, Texas, a joint venture between Sinclair Pipe Line Company and Continental Pipe Line Company. Designed for operation in the 6700 mc band, this new system is unique in that it will provide 85 channels for the users.

Longest system, not yet underway, is a 900-mile, 33-station system for Texas Gas Transmission Company between Lake Charles, Louisiana, and Owensboro, Kentucky. This system will operate in the 2000 mc band.

Also under construction is a 340-mile, 17-station system between Bridgeport, Illinois, and Findlay, Ohio for Ohio Oil Company. This 24-channel system will operate in the 6700 mc band.

A three-hop, 2000-mc system for Atlantic Seaboard Corporation (subsidiary of Columbia Gas System) in Virginia will cover 84 miles and include one hop of 69.25 miles.

In California, Richfield Oil Corporation has a two-station system completed and eight remaining stations are being installed or are on order. Richfield has had a three-station system in operation for two years.

Service Pipe Line Company is installing its first microwave link in its extensive communications system. A 90-mile, 4-station system, operating in the 6700 mc band, it will provide 5-channel facilities between El Reno and Bretch, Oklahoma.

Sinclair Pipe Line Company's extension of its system in Pennsylvania from East Pittsburgh to Clinton, Ohio, will add nearly 120 miles to the 1700 miles of microwave circuits owned or jointly-owned and operated by the company. The extension will have six stations and operate in the 2000 mc band.

Union Oil Company has its first microwave system in operation, a two-hop, 40-mile system with four voice channels and four telemetering channels. The equipment operates in the relatively unused 2450-2700 mc band.

General Petroleum Company placed into operation in the past year a short hop 960 mc system between Santa Fe Springs and Brea, California.

Kentucky West Virginia Gas Company is building a three-station, 6700 mc, 60-mile system, linking Maytown and Jenkins, Kentucky.

Technical Advances

Progress in the design of microwave equipment comes rapidly. Today's gear may not be out-of-date tomorrow, but tomorrow's equipment will more than likely be a big improvement.

Always on the lookout for ways to improve reliability — which is the chief problem on any system — the manufacturers have come up with a variety of ideas to achieve this goal.

On one system — Continental-Sinclair — standby power supply will be provided by batteries, which are continually float-charged through use of mag-amp controlled chargers. In event of power failure, response is instantaneous, with no delay required to get auxiliary equipment into operation.

Another approach to improved reliability is the dual-path, single frequency, polarized transmission design now offered by one manufacturer. In this system, there is complete duplication of RF throughout at each station. A common dish is used, and the two transmissions, while on the same frequency, are cross-polarized. Even should one RF fail, the other will continue to operate and provisions for an alarm indication are made advising that one unit is inoperative.

A growing use of passive or "billboard" type reflectors is reported. These can be used to literally "bend the beam" around obstacles in the path.

Equipment is becoming more compact. Fewer tubes are being used, and where they are necessary, ARINC tubes are used. Greater use is being made of transistorized equipment, magamps, klystrons, mechanical filters, and other devices.

An up-to-date tabulation of U. S. pipe line microwave systems is presented on the following page. This table is keyed to a separate map, enclosed as an insert supplement to this issue, and which is entitled "Pine Line Microwave System." This is the first map of this type ever to be published.

PIPE LINE MICROWAVE SYSTEMS

May, 1956

Here's where the more than 17,000 miles and 700 stations are located, according to the latest Petroleum Engineer Survey

(Numbers in first column refer to separate microwave map included with this issue as special supplement)

Map No.	Name of Company Owning and/or Operating System	Date In Service	From	To	Length Miles	No. Of. Stations	Freq. Band	No. of Channels
1	American Oil Pipe Line Co. (Formerly Pan American)	1951	Snyder, Texas	Eldorado Texas	143	9	6700	7
2	Atlantic Seaboard Corporation	U. C.	Standardsville, Va.	Criglersville, Va.	100	3	2000	—
3	Buffalo Pipe Line Corporation	1954	Caledonia, N. Y.	Marrowlock Hill, N. Y.	19	2	960	1
4	Colorado Interstate Gas Co.	1954	Colorado Springs, Colo.	Keyes, Oklahoma	281	7	2000	3
5	El Paso Natural Gas Company (San Juan System)	1952	Farmington, N. Mex.	Topock, Arizona	450	11	6700	4
5	El Paso Natural Gas Company (Permian System)	1953	Midway, Texas	Jal, N. Mexico	287	13	2000	21
5	El Paso Natural Gas Company (Western System)	1954	El Paso, Texas	Farmington, N. Mex.	478	12	2000	4
—	General Petroleum Corp.	1955	Santa Fe Springs, Cal.	Brea, California	15	2	960	1
6	Humble Pipe Line Company	1953	Houston, Texas	Kempner, Texas	450	19	6700	3
7	Industrial Gas Supply Corp.	1955	Houston, Texas	Alcomag, Texas	20	2	6700	10
8	Interstate Petroleum Communications, Inc. (Shell P. L.)	1951	Cushing, Okla.	Elk City, Oklahoma	160	8	6700	3
9	Keystone Pipe Line Company	1949	Philadelphia, Pa.	Reading, Pa.	70	5	2000	6
9 & 25	Keystone-Sinclair System	1954	Philadelphia, Pa.	Pittsburg, Pa.	460	23	2000	9
10	Michigan Wisconsin Pipe Line Co.	1954	Hawsford, Texas	Detroit, Michigan	1540	59	2000	6
11	Mid Valley Pipe Line Company	1950	Longview, Texas	Lima, Ohio	1000	42	6700	10
12	Natural Gas Pipe Line Company of Amorica	1953	Downers Grove, Ill.	Aurora, Illinois	20	2	6700	13
13	Natural Gas Storage Company of Illinois	1953	Herscher, Illinois	Cabery, Illinois	15	2	6700	2
14	New York State Natural Gas Corporation	1955	Syracuse, N. Y.	Utica, N. Y.	60	3	6700	2
15	Ohio Oil Company	U. C.	Findlay, Ohio	Bridgeport, Illinois	340	17	6700	24
16	Oklahoma Mississippi River Products Pipe Line (Sunray)	1952	Purcell, Oklahoma	Ada, Oklahoma	82	5	6700	1
17	Oklahoma Natural Gas Company	1954	Muskogee, Oklahoma	Chickasha, Okla	220	11	2000	15
18	Panhandle Eastern Pipe Line Co.	1952	Kansas City, Mo.	Tuscola, Illinois	400	18	6700	9
19	Plantation Pipe Line Company	1953	Bremen, Georgia	Athens, Tennessee	156	7	2000	13
20	Platte Pipe Line Company	1954	Casper, Wyoming	Wood River, Illinois	1007	44	6700	9
21	Richfield Oil Corporation	1953	Los Angeles, Calif.	Sulphur Mtn., Calif.	60	3	6700	2
21	Richfield Oil Corporation	U. C.	Anaheim, Calif.	Bakersfield, Calif.	223	11	2000	24
22	Salt Lake Pipe Line Company	1952	Salt Lake City, Utah	———	35	2	960	4
23	Service Pipe Line Company	U. C.	Bretch, Oklahoma	El Reno, Okla.	90	4	6700	5
24	Sinclair-Continental System	U. C.	Ponca City, Okla.	Houston, Texas	760	29	6700	85
25	Sinclair Pipe Line Company	1953	Cushing, Okla.	Independence, Kans.	190	9	6700	24
25	Sinclair Pipe Line Company	1953	Independence, Kans.	Salisbury, Missouri	260	13	6700	23
25	Sinclair Pipe Line Company	1953	East Pittsburgh, Pa.	McDonald, Pennsylvania	20	2	6700	5
25	Sinclair Pipe Line Company	1954	Salisbury, Missouri	East Chicago, Indiana	475	21	2000	24
25	Sinclair Pipe Line Company	U. C.	Clinton, Ohio	East Pittsburgh, Pa.	90	5	2000	5
26	Southern Counties Gas Company	1952	Los Angeles, Calif.	Santiago Park, Calif.	40	2	6700	5
27	Standard Oil Company of Indiana (Products Pipe Line Dept.)	1954	Morehead, Minnesota	Mandan, North Dakota	200	8	2000	4
28	Sun Pipe Line Company	1953	Hoffman, Texas	Humble, Texas	15	2	960	1
28	Sun Pipe Line Company	1955	Sour Lake, Texas	Saratoga, Texas	13	2	960	1
28	Sun Pipe Line Company	1955	Barbers Hill, Texas	Liberty, Texas	18	2	960	2
29	Tennessee Gas Transmission Co.	1955	Kinder, Louisiana	Oakdale, Louisiana	23	2	6700	2
30	Texas Company	1953	Salem, Illinois	Kaskaskia, Illinois	20	2	960	2
31	Texas Eastern Transmission Corp.	1954	Shreveport, La.	Linden, New Jersey	1400	57	2000	8
32	Texas Gas Transmission Corp.	1950	Guthrie, Louisiana	Sharon, Louisiana	45	3	6700	5
32	Texas Gas Transmission Corp.	U. C.	Owensboro, Kentucky	Lake Charles, La.	900	33	2000	—
33	Texas Illinois Natural Gas Pipe Line Company	1952	Houston, Texas	Chicago, Illinois	1004	40	6700	9
34	Transcontinental Gas Pipe Line Corporation	1952	Falfurrias, Texas	Newark, New Jersey	1760	62	2000	7
35	Trunkline Gas Company	1954	Houston, Texas	Tuscola, Illinois	1000	32	2000	8
36	United Gas	1953	Jackson, Miss.	Montpelier, La.	126	6	2000	8
37	Union Oil Company	1955	Torrey Hill, Calif.	Mulholland, Calif.	35	3	2000	4
38	Wilcox Trend Gathering System, Inc.	1954	Cuero, Texas	Mineral, Texas	62	4	6700	5

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EXCLUSIVE

Selective Telemetering Makes Remote Control More Effective

L. G. Walker

Motorola Communications and Electronics, Incorporated, Chicago, Illinois

TELEMETERING is an essential element of any remote control system. It is impractical to assume control of a function without knowledge of what is taking place. Considering telemetering in its broadest sense, the "open" or "closed" indication provided by a supervisory control system supplies this information. Frequently, this data is inadequate and the incremental information normally associated with telemetering is needed.

It is impossible to control the flow of oil through a pumping station by knowing only if a valve is open or shut. Pressure, flow, temperature — these values and many more are required for effective remote operation of pipe line pumping stations, tank farms, etc.

Most systems are actually installed with much less data provided to the remote operator than he would have if he were manning the station. This is strictly a matter of economics. If the comprehensive instrumentation normally found on a station control panel were to be duplicated by telemetering, most budget requests would never leave the engineer's desk. The industry needs and can use less costly telemetering systems. Therefore, a compromise must be reached between the data transmitted and the capital expenditure which can be justified. Selective telemetering is a key to this situation that should not be overlooked.

Certain telemetered data must, of necessity, be continuously received. Furthermore, only a minimum delay is acceptable in its full and final presentation. Channels for these signals are best provided by multiplexing the communication media established between the control point and the remote station.[1] However, other data is needed only at the operator's request. These may be periodic readings for log records, for investigations following various alarms, or for information to permit adjustments to be made. Such data is best provided by selective telemetering or interrogative measurement.

Selective telemetering provides economics by permitting:

1. Shared use of the telemeter communication channel, thereby minimizing the cost of multiplexing equipment. This also reflects a reduction in bandwidth consumed or a reduction in the cost of leased line facilities.
2. Shared use of telemeter instrumentation. This item is probably the most important as it constitutes the major item of cost.
3. Shared use of sensing devices. This is particularly useful where electrical quantities may be conveniently switched.
4. Reduction in space through use of less apparatus.
5. Reduction in maintenance cost also by virtue of less equipment to maintain.

While strictly not economic factors, additional assets of selective telemetering include:

a. More efficient remote operation by making more effective use of the highly trained men at the control point.
b. Greater ease of channel supervision since fewer channels are required.
c. Telemeter selection which may be programed to obtain quantities of data without manual supervision while still achieving the economics of shared equipment use.

In planning a typical system, several factors must be given careful consideration.

1. **The use to which the data is to be put.**
2. **The instrumentation requirements and limitations.**
3. **The method to be used to switch the various quantities.**

Uses

Where many quantities are to be read in rapid succession, where system adjustments are to be based on telemetered data, or where trouble is to be localized by data obtained, high speed telemetering must be applied. Coding schemes based on variable sub-audio frequencies are excellent for this purpose (see Fig. 1). Data of this type requires rapid correction to be effective. Otherwise, the operator cannot make intelligent adjustments without long waiting periods to check the magnitude of correction needed.

Where hourly readings must be taken and recorded, a long telemeter correction cycle can be most annoying to the operator. If the indication is being used to localize system trouble, any but the highest speed coding systems may completely miss the disturbance. For such purposes, the cost of higher speed devices can be easily justified, especially in light of the improved utilization through shared use.

Another use is the longer term monitoring of a quantity to determine a trend. This closely resembles continuous telemetering but is not truly so since the same equipment may be used to graph many similar variables by automatic programing of the telemeter switching. Where many similar quantities are desired and variation is sufficiently slow, the longer correction cycle is entirely adequate. A group of temperature readings is an excellent example. In other instances, a single quantity may be desired over a period of time, but the desired measuring point may change with the time of day, from day to day, or with various system conditions. A single telemeter system and recording device may be switched at will, whereas it would not be economically feasible to provide complete instrumentation of all data simultaneously. For such stems, pulse rate or pulse duration coding is frequently chosen.

Instrument Requirements

The quantities to be measured, the

[1] "The Motorola System of Telemeter Multiplexing," L. G. Walker, National Telemetering Conference Paper, 1953.

sensing elements available for this measurement, the restrictions imposed by circuit details, and the compatibility of the various readings all govern system layout.

Perhaps the simplest application involves a number of similar quantities capable of being switched into one telemeter transmitter and read or recorded on one telemeter receiver (Fig. 2). Voltages on a common base at various points in a station, temperatures at various points in a machine, or current on various lines are good examples. In this case, joint use of the communication channel and all instrumentation can achieve maximum economy.

Where it is impractical or impossible to directly switch the measured quantity, the same effective use is provided by associating a sensing element with each quantity and switching sensing element outputs.

An excellent example of this type system is provided in Fig. 3.[2] This system involved a remote tank farm. It was desired to accurately observe the oil level in a particular tank being filled. To achieve minimum operating cost, personnel 150 miles away, at a station manned 24 hours a day could perform this duty if they had the data to observe. Selective telemetering transmitted by frequency shift voice frequency carrier was determined to be most economical.

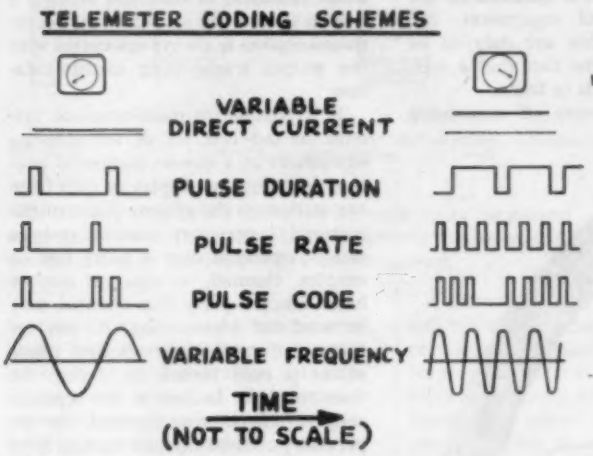

FIG. 1. Various telemetering coding schemes based upon the use of variable sub-audio frequencies.

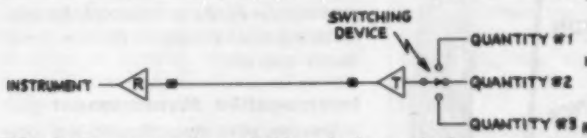

FIG. 2. By means of a switching device a single communication channel can be used to telemeter a number of similar quantities measured by different instruments.

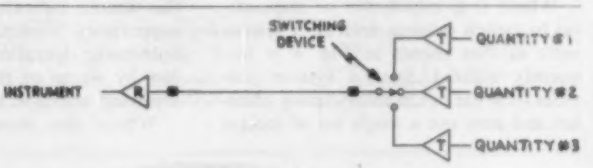

FIG. 4. When it is impractical to switch current circuits, transmitting instruments can be switched so that only one channel and a single set of receiving and indicating or recording instruments need be used.

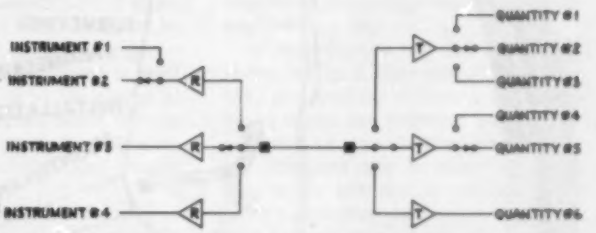

FIG. 5. Any combination of selective telemetering schemes, such as this one, can be applied in a particular system.

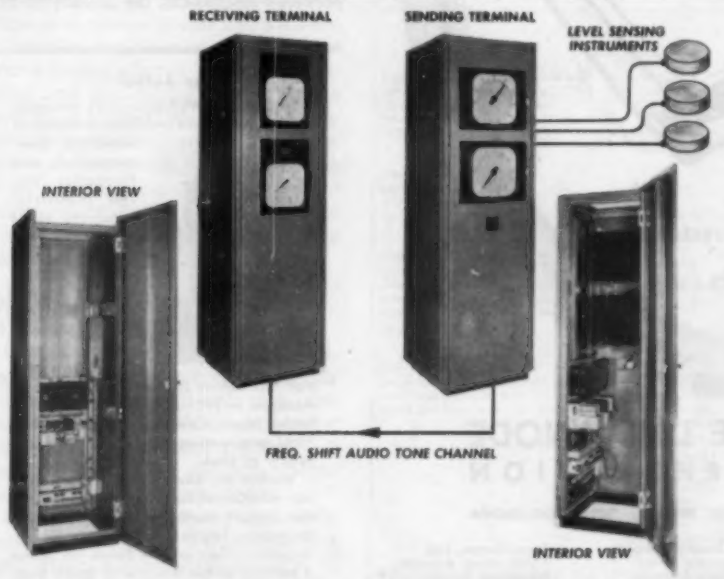

FIG. 3. Level sensing element outputs from various tanks can be switched to the telemeter system as desired.

Individual tank gauge sensing elements were installed on each tank. The person setting up the tank valving, switches the proper tank to the telemeter system and can go about his business. Tank levels with an accuracy of ⅛-in. in 50 ft are presented continuously to the remote operator who can issue appropriate instructions when the proper level has been reached. To provide this accuracy, note that a vernier system has been used. One element in the tank gauge measures fractions of a foot while a second measures total feet. Each is coded separately, transmitted via a separate frequency shift tone channel, decoded and displayed on a separate indicator.

The communication media is a pri-

[2] "Telemetering System for Remote Tank Level Reporting" by Dayton N. McMillan, PETROLEUM ENGINEER, page D-19, November 1952.

vately owned wire line for pipe line communication. Voice and telegraph service is also provided by this line. Suitable separation filters prevent interference between the voice and the telemeter tone channels. Telemetering has made this operation more efficient; selective telemetering has made it economically feasible and has minimized bandwidth so that the entire service can be handled on existing facilities.

Where it is impossible or impractical to switch sensing devices, a system such as that shown in Fig. 4 is frequently utilized. Such a system provides joint use of the telemetering channel and may use a single set of receiving and indicating or recording instruments if adequate scale compatibility exists between the various quantities. Such systems are common in the power utility field where supervisory control is used to operate a major substation.

A unique feature of this supervisory control equipment makes such a system most attractive. This feature is the important one wherein a point may be selected indefinitely without tying up the remote indication function of the supervisory control equipment. No automatic operations are delayed or lost by virtue of the fact that a telemetering selection is in force.

Where this feature of combining telemetering selection with device selection can be used, supervisory points are conserved, minimizing the cost of the overall system with no sacrifice in performance.

Any combination of selective telemetering schemes may be applied in a particular system. Fig. 5 shows such a combination of the various selection possibilities previously discussed. Supervisory control can provide coordinated switching at each end of such a system so that the proper receiving instrumentation is always associated with the proper transmitting instrumentation.

It is possible in multi-terminal systems to use one set of telemetering equipment at a master station to provide decoding and display of data from any station on the system. Since multi-terminal supervisory control systems can be operated over a party line or simplex channel, a separate narrow band simplex party line channel may be used for telemetering. At any remote station, the telemetering transmitter is only turned on during the time required. In lieu of the separate simplex telemetering channel, the supervisory control channel itself may be used for transmitting the telemetering signals if a timed interval of telemetering transmission is established or if provision is made to interrupt the telemetering transmission to restore supervisory control.

Interrogative Measurement

Interrogative measurement is a special type of selective telemetering characterized by an interrogation and answer type of operation. Contrary to previous discussion, the answer in this

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The Author

Leonard G. Walker is sales manager for microwave and industrial products of Motorola Communications and Electronics, Inc. The industrial products he is responsible for include supervisory control equipment, power line carrier, audio multiplexing, and power transmission line carrier couplers. Walker joined Motorola in 1951 after fifteen years with Idaho Power Company. He is an electrical engineering graduate of the University of Utah.

Walker has been active in the American Institute of Electrical Engineers' carrier current committee and the Radio-Electronics-Television Manufacturers Association's Carrier Task Force. He is also a member of the Institute of Radio Engineers and the National Society of Professional Engineers.

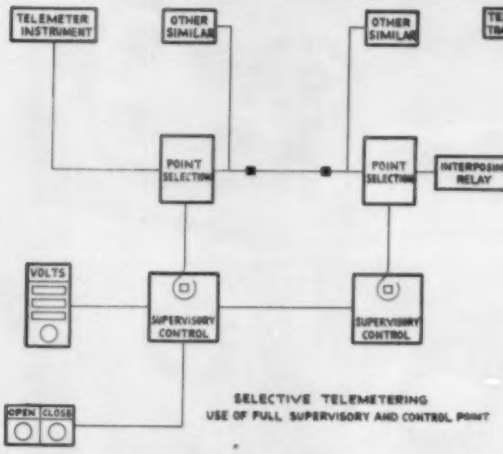

FIG. 6. Showing how a telemetering system can be placed in operation and observed while the operator performs control functions on the supervisory control system.

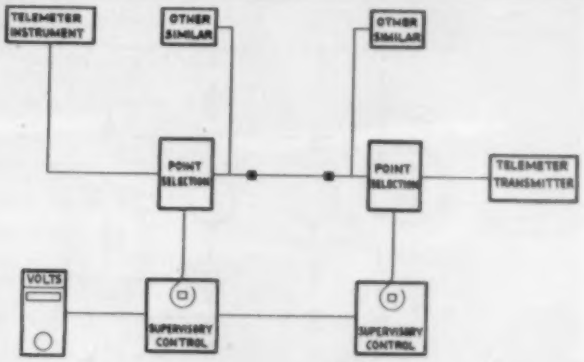

FIG. 7. This modification of the system shown in Fig. 7 is used when operator is not required to perform control functions on other points in the system at the same time that the telemetering data is being received.

type of system is a single measurement rather than the establishment of a continuously varying indication that continues until cancelled. Interrogative measurement systems usually use telemetering coding of the pulse code type. The measurement may be received on indicating dials, a cyclometer counter, or by teletypewriter presentation.

Typical examples are the interrogative measurement of tank levels, the indication of kilowatt hours consumed during a previous time interval or the temperature at a point at the time of interrogation, the quantity of units passing a measuring point in the system during a previous time interval, river flow data, or snow level data.

Frequently, the interrogative measurement system contains the selection or interrogating function as part of the overall coding scheme. A code is established and transmitted to the remote location. Reception and decoding initiate the transmission of the proper return code containing the identification of the measuring point, and the desired measurement. Following the receipt of this data, the system is reset until a subsequent request is initiated.

Supervisory Control As a Switching Media

Supervisory control is the most universally adapted switching media for selective telemetering and may also provide the interrogation function for interrogative measurement systems. It can be adapted to any selection scheme and any type of instrumentation.

Application generally falls into three basic categories. Fig. 6 shows the first type. Here, supervisory control is used to connect the telemetering instrumentation in the same fashion as it would be used to open and close a circuit breaker or other device. A full supervisor and control point is required for this operation as well as a complete set of interposing relays. Latching type interposing relays are normally employed so that the telemetering selection will be retained until cancelled by an "open" request from the supervisory equipment. This scheme is used when telemetering is to be placed in operation and observed while the operator performs control functions on other points of the supervisory control system.

An additional special facility may be provided by the supervisory control in this type system. Where the telemetering transmitter has limit alarm contacts, this contact information may be made to appear in place of the usual open and close device position. The supervisory control may also be used to provide automatic alarm of abnormal conditions requiring observation of the telemetering data.

A modification of this system is shown in Fig. 7. Here you will note that the interposing relays have been omitted and the selection function itself used to provide telemeter switching. The data may be observed for as long as the selection is retained.

This switching arrangement may be used for information that does not require the operator to perform control functions on other points in the system

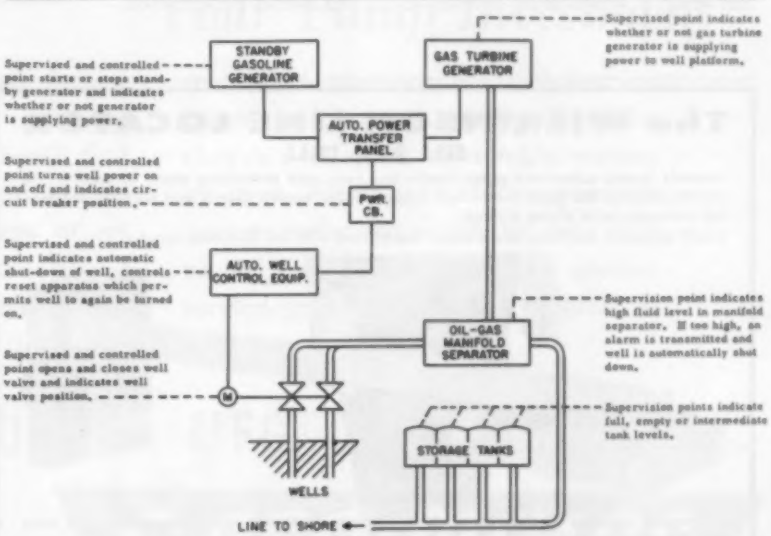
Supervised point indicates whether or not gas turbine generator is supplying power to well platform.
STANDBY GASOLINE GENERATOR
GAS TURBINE GENERATOR
Supervised and controlled point starts or stops standby generator and indicates whether or not generator is supplying power.
AUTO. POWER TRANSFER PANEL
Supervised and controlled point turns well power on and off and indicates circuit breaker position.
PWR. CB.
Supervised and controlled point indicates automatic shut-down of well, controls reset apparatus which permits well to again be turned on.
AUTO. WELL CONTROL EQUIP.
Supervision point indicates high fluid level in manifold separator. If too high, an alarm is transmitted and well is automatically shut down.
OIL-GAS MANIFOLD SEPARATOR
Supervised and controlled point opens and closes well valve and indicates well valve position.
M
Supervision points indicate full, empty or intermediate tank levels.
STORAGE TANKS
WELLS
LINE TO SHORE

FIG. 8. Pumps can be started and stopped at booster pump stations, with full continuous supervision of the operation. Valves and valve controllers can be operated remotely.

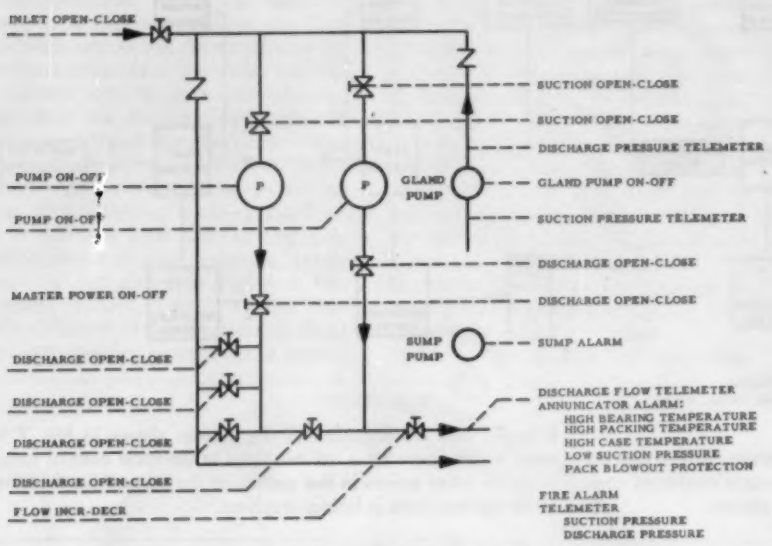

FIG. 9. Breaker control of primary power to wells, start and stop of the emergency generator, and automatic shutdown of the platform can be controlled by two-way radio from the shore location. Level supervision of tanks, alarm indication for high fluid level in the separator tank, low battery, and other functions that may be required can be reported to the shore base.

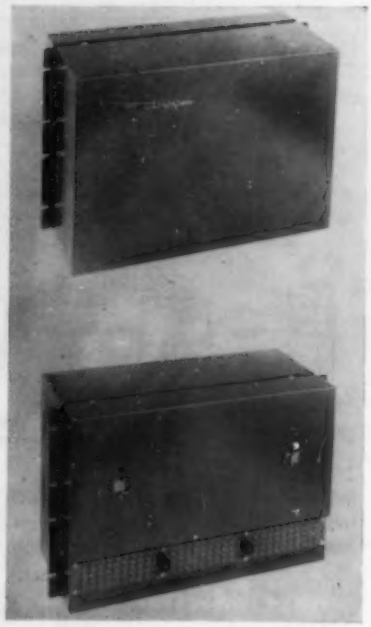

FIG. 10. Front and rear view of a Motorola supervisory control equipment case with dust covers in place. These cases are designed for standard relay rack mounting.

at the same time that telemetering data is being observed.

Fig. 8 shows a system layout where the telemetering is closely associated with devices being controlled by the system. When a point is selected to initiate control of a specific device, the telemetering associated with this point is simultaneously placed into operation. It is obvious that this is a feature that only a select-before-operate supervisory control system can provide. Following this selection, the telemetering may be observed for any desired period and then cancelled. Alternately, the operator may open and close the device while observing the telemetering. The addition of a telemetering function in this fashion in no way limits the supervisory control equipment and actually in this arrangement, enhances the overall performance.

When considering the use of supervisory control for telemeter selection, especially when the scheme in Fig. 8 is to be employed, it is important that a supervisory control selection does not tie up the system. Indications of automatic operations at the remote station must still be received immediately, even though the point selection associated with the telemetering is in force.

The point selection relays at both the master and remote station may be employed to switch the telemetering instrumentation so that the proper transmitting and receiving units are always properly associated.

In Fig. 9 is pictured an application for supervisory control which, when coupled with telemetering, will provide continuous supervision, and control at a remote installation.

Fig. 10 shows the front and rear view of a supervisory control equipment case. These equipment cases, used to house all of the supervisory control components, are designed for standard relay rack mounting. This permits easy additions to the system requiring no complicated panel punching. Relay rack construction provides inexpensive and compact mounting. When the dust covers are removed, the remaining case is only one inch thick, providing complete access for maintenance. ★ ★ ★

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Prime movers at Sinclair's Forest City, Illinois, station are installed out-of-doors except for this shelter.

EXCLUSIVE

Pump Station Remotely Supervised

Satisfactory operation of an unattended station demands close attention to selection of equipment

Ralph J. Osborn
Assistant Chief Electrical Engineer
Sinclair Pipe Line Company

FOUR basic requirements were considered essential for satisfactory operation when Sinclair Pipe Line Company started the design of its remotely supervised Forest Station near Forest City, Illinois:

1. *Pumps, prime movers, and station auxiliaries that were highly dependable and able to operate without frequent attention or maintenance.*
2. *Numerous protective and control devices to shut the station down in the event of equipment failure or other dangerous condition.*
3. *A suitable relay and interlock system for opening and closing suction and discharge valves and starting the pump motor.*
4. *A reliable communication link equipped with supervisory control and telemetering equipment.*

Pumps and Prime Movers

Pumping equipment at Forest consists of three 14-in., two-stage, 1800-rpm pumps and one 14-in. single-stage, 1800-rpm pump. All are equipped with mechanical seals.

There were a number of factors that influenced Sinclair in the selection of weatherproof motors at Forest. The initial cost, maintenance, and heating of a building for the pumping equipment seemed unwarranted for an unattended station. With the equipment installed in the open, there was no justification for the high initial cost of explosion-proof or TEFC motors. Three 1250-hp and one 600-hp weather protected 2300-v, 1800-rpm squirrel-cage induction motors were selected to drive the pumps.

General practice on Sinclair electric stations had been to use metal-clad switchgear for starting control of pumping motors. Time was an important factor in the completion of this station, however, and it was necessary to use large air-break, motor-starting contactors due to the long delivery schedule for metal-clad switchgear. One outdoor metal-clad breaker equipped with capacitor trip was available for the station main breaker. To provide maximum protection, this breaker was installed in the substation.

The experience of Sinclair and the pipe line industry in general indicated that centrifugal pumps equipped with mechanical seals and squirrel-cage induction motors made up a highly dependable pumping unit requiring a minimum of attention and maintenance. It was felt that these units were quite suitable for unattended operation when equipped with the proper protective devices.

Electric motor-operated valves were provided in the suction and discharge valves of each pump. These were arranged to close whenever the pump was not running so that pump seals were not subjected to line pressure when the pump was not running. The discharge operator was also necessary to permit starting against a closed discharge.

Protective and Control Devices

It was considered necessary or desirable to protect against a number of possible troubles. In the event of some types of trouble, it was considered advisable to shut down the pumps affected and lock them out so that they could not be started remotely. Other troubles were such that it was considered safe to restart the pump as soon

as the trouble cleared. In a few cases, it was considered necessary only to give an alarm without shutting down any unit. The following is a breakdown of the various protective devices:

Lock-out Points

High bearing temperature on pump or motor.
Excessive seal leakage.
Power failure to electronic instruments.
Motor over current.

Self-reset Points

Low suction pressure.
High line pressure.
High case pressure.
High pump-case temperature.

Alarm Only

High station sump level.
Ground on 2300-v power system.
Low instrument air pressure.

A drop type of annunciator was provided to record the operation of any protective device. This makes it possible for a man checking the station to determine immediately the cause of any shutdown or alarm. Also, the operation of any protective device causes a red light to come on and a bell to ring at the dispatcher's office in Independence, Kansas. The dispatcher can tell that the station is in trouble but not which of the protective devices has functioned. It would be necessary to dispatch the closest man to the station in the event of any trouble, so a more elaborate remote alarm system was not justified.

Pressure

A complete system for electrical pressure indication and protection was on hand at the time this station was being designed. The system utilized strain gage cells in conjunction with an a-c type of amplifier for pressure measurement. Incorporated in the amplifier were adjustable relays for the various pressure protective points. As this equipment was available, it was used instead of simpler less expensive hydraulically operated pressure switches and Bourdon gages.

The electronic system has proved highly dependable and required very little maintenance. Fail-safe circuitry was used in the design of the equipment so that any failure should shut the units down rather than permit them to run without protection.

Temperature

All over-temperature protection is provided by remote bulb liquid-filled type thermostats. The remote bulbs were installed as close as practicable to the actual bearing surface of the pump and motor bearings. A separable socket

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was installed in the pump case and the actual bulb was installed in this socket so that it is not subjected to erosion by the crude oil stream. The bellows and switch assembly are housed in an explosion-proof housing mounted on the pump bedplate. The capillary tubing connecting the remote bulb and the bellows is armored to protect it from mechanical damage.

It was felt that this type of over-temperature protection had more than the required accuracy and repeatability but at the same time was highly dependable and maintenance free.

The pump bearings are cooled by circulating some of the crude oil stream through suitable cooling coils. Several times the pump bearing protective devices have prevented serious damage when the coolant lines have become clogged.

Seal Leakage

Failure of a mechanical seal on one of the pumps could have disastrous results if the pump were not quickly shut down and isolated from the line pressure. To provide this protection, the drainage from the seals of each pump was piped to a small tank with a restricted outlet. The tank was equipped with a float switch. If the rate of seal leakage exceeds the rate at which the oil can flow through the restricted outlet, the oil level in the tank rises, causing the float switch to operate and shut down the pump.

During winter months, crude oil would congeal in the tank and not flow through the restricted outlet if the drain lines and tank were not heated. A length of thermostatically controlled mineral-insulated heating cable was wrapped around the drain lines and tank to provide the required heat. The lines and tank were then covered with insulating material.

Sump Tank

The station sump tank was provided with liquid level switches to automatically start and stop the sump pump as required. As an additional precaution, an extra high-level contact was installed. This contact provides an alarm in the event the sump pump fails to work properly.

Control Valve

An air-operated throttling valve was installed on the discharge of the station. Controllers were provided so that this valve acted to hold suction pressure above a minimum value and line pressure below a maximum value.

In addition, a flow controller with a "rate of flow increase limiter" was installed. It was felt that the starting of a pump at Forest would produce undesirable line surges and temporary high flow rates if no special precautions were taken. The controller has a minimum and maximum set point plus a rate of increase adjustment. The flow meter scale is calibrated from 1 to 10.

As an example of the operation of this controller, assume that the minimum setting is 7.5, the maximum set-

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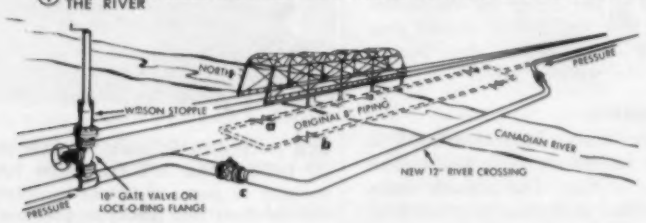

② TAP WAS MADE WITH WmSON-HILLCO MODEL 660 TAPPING MACHINE

③ WmSON STOPPLE REPLACED TAPPING MACHINE ON CLOSED VALVE

④ LINE WAS PLUGGED ISOLATING SECTION BETWEEN STOPPLE AND VALVES a. & b. (CITY LOOP SYSTEM MAINTAINED SERVICE TO RIVER FROM EACH SIDE.)

⑤ ISOLATED SECTION WAS THEN CUT AND NEW 12" CROSSING TIED INTO 10" LINE

⑥ FOR REMOVAL OF VALVE, LOCK-O-RING PLUG WAS INSTALLED IN L-O-R FLANGE WITH TAPPING MACHINE

⑦ TAPPING MACHINE AND GATE VALVE WERE REMOVED AND BLIND FLANGE INSTALLED

THIS ENTIRE OPERATION WAS THEN REPEATED ON THE OPPOSITE SIDE OF THE RIVER

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The Author

R. J. Osborn, assistant chief electrical engineer of Sinclair Pipe Line Company, was born at Pawhuska, Oklahoma. He was graduated from Independence, Kansas, Junior College in 1943. He then entered military service and during World War II served with the U. S. Navy as an aviation radio technician and later was commissioned an ensign. At the completion of his military services, he entered Kansas State College, from which he was graduated with a BS degree in electrical engineering in 1948.

Osborn entered the employ of the Sinclair Pipe Line Company in June, 1948, as an electrical engineer in the general engineering department.

He is a member of the American Institute of Electrical Engineers and is a registered professional engineer in the state of Kansas.

ting is 9.5, and the rate of increase is set for 2 divisions per hour. With no units at the station running, the flow rate is 7.0. One unit is started and the flow controller permits the flow to rise immediately to 7.5. When the flow reaches this minimum setting, however, the control causes the control valve to throttle so that initially the flow does not exceed this amount; gradually the flow rate increases so that at the end of 15 min the flow rate is up to 8.0.

Assuming that at this point the flow rate is as high as it will go with only one unit going, the dispatcher then starts the second unit. No immediate change in flow results. The controller regulates the control valve so that a gradual increase in flow takes place; at the end of 15 min, the flow will have reached 8.5 and will continue to increase until the full capacity of the two units is reached. If the flow rate reaches 9.5, the control will cause the valve to throttle so that this flow rate is not exceeded.

An automatic air dryer was installed to remove moisture from the instrument air. It was also necessary to add filters to the air lines to prevent particles of the desiccant from the dryer from fouling the instruments.

Sequence Operation

The following sequence of events is controlled by a mutiple-cam, motor-driven timer together with various interlocking switches.

Starting

1. Suction valve starts opening.
2. Motor starts when suction valve reaches full open (if discharge valve is closed).
3. Discharge valve starts opening.
4. At the end of 4½ min, the circuits are checked to be sure the discharge valve is full open. If it is not, the unit is shut down. If, for any reason, the starting cycle is not completed, the unit goes through the stop cycle listed.

Stopping

1. Motor is stopped.
2. Discharge valve starts closing.
3. 30 sec later, the suction valve starts closing.

Total time required to run through a starting and stopping cycle is 8 min. This delay between repeated starts was considered desirable to prevent the possibility of motor overheating by too frequent starting.

Interlocks are provided so that the unit cannot be started if any of the protective devices are in the tripped position.

Communications Link

Initial design of Sinclair's microwave system had provided ample channel space for telemetering and two-voice circuits. The telemetering channel had plenty of space left for the addition of a tone channel for supervisory control. The only modification required for supervisory control was the addition of the narrow band tone-channel equipment.

Pulse-type coding is used on the supervisory control equipment. Each signal consists of a group of pulses. The number of pulses in each group is varied to transmit the desired intelligence.

To perform a start or stop operation, the dispatcher pushes a selection button for the specific unit involved. A white selection light then lights to indicate that the proper unit has been selected. He then presses either the start or stop button to perform the desired function. A green light is burning anytime the unit is running and an amber light when the unit is stopped. If the condition of the unit changes for any reason other than the operation of the push buttons on the dispatcher's panel, an alarm bell sounds and the light flashes.

Continuously indicating pulse-duration type of telemetering is provided for station suction and discharge pressures and station flow rate.

This station will soon complete its second year of satisfactory operation.

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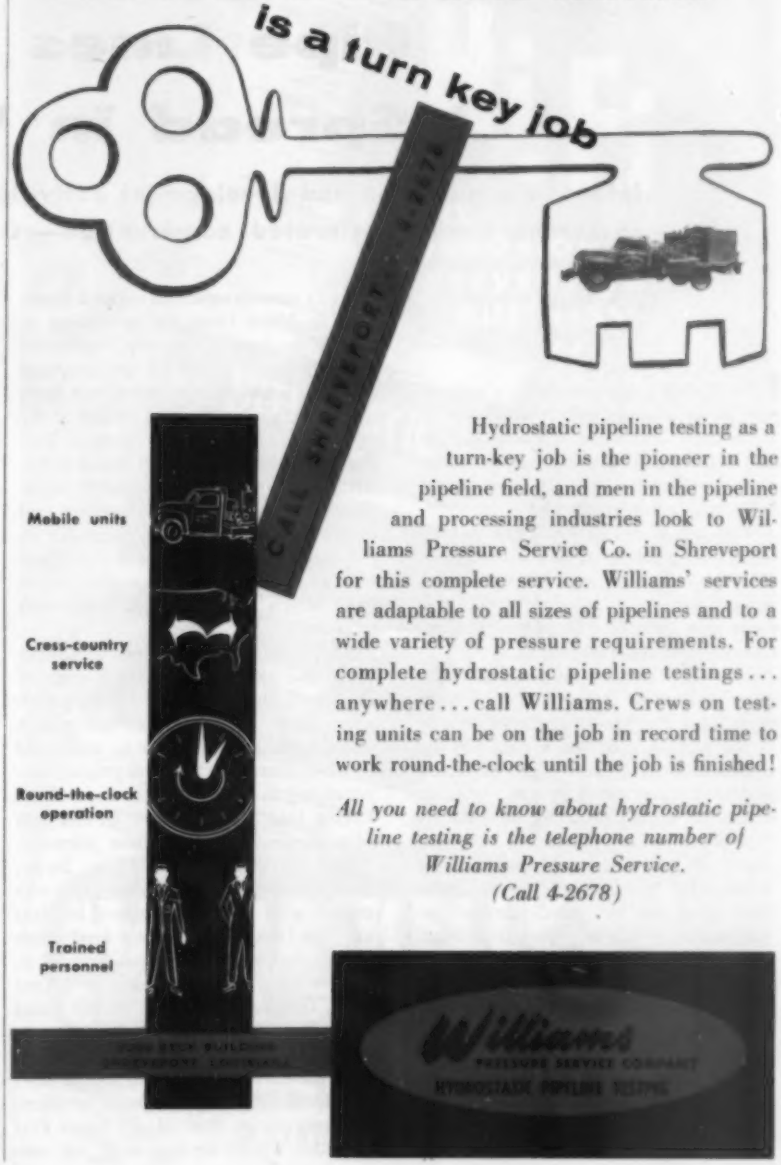
is a turn key job



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Pump station on Shell's "Lightline," between Palmarejo and Cardon.

P 615.

Pipe Lines Spread in Venezuela

Intensive exploration and development activities, greater utilization of gas resources have accelerated construction — Greater expansion foreseen.

O. J. Marr

PIPE LINES are becoming a natural part of the scenery over a good part of Venezuela, and there is every indication that their spread will be even more rapid in the next 10 years than during the fertile postwar decade.

Two main factors back this prediction. The granting of new concessions will open up vast new territories for exploration, and as developed, will mean new gathering problems, new refineries, and new pipe lines.

The other promise of progress is the growing interest in the nation's wealth of natural gas. On the extraction side of the picture, a dramatic fact was the completion of Creole's gas injection plant, putting natural gas, hitherto flared, to work increasing oil yield by revivification of producers showing signs of weariness. Moreover, the Venezuelan government has an ambitious program for petrochemical development, which is expected to begin showing tangible results in 1957.

Intensive development of existing areas has resulted in new pipe line construction to serve two purposes: (1) Increase field-to-refinery capacity, such as the looping of Creole's Ule-to-Amuay 26-in. line, and the Shell 30-in. Palmarejo-to-Cardon line to feed the two big Paraguana peninsula refineries, and (2) service newly developed areas, such as Mene Grande's operations in the Oficina region of eastern Venezuela.

In the main, most of the overland pipe line construction work has been direct and uncomplicated. Much of the pipe line is on skids above ground. This has been made possible by sparse population, dry climate, and scrubby vegetation. Most difficult engineering and protection problems are necessary in the jungle regions, such as the last third of the Temblador-to-Boca de Uracoa line, which goes through lush delta territory.

The Maracaibo operations are something else again. About 1000 miles of line now webs the lake floor, along with more than 150 miles of submarine cable from power plants to wells and flow stations. The extreme precautions necessary in laying the gas lines of the Creole injection plant are an example of underwater construction practices. There were 65,000 ft of 24-in., 26-in., and 30-in. pipe laid. The pipe was coated with asphalt, wrapped in glass cloth and then in heavy wire mesh, then 4½-in. thick concrete cast around it, to give a negative bouyancy of 15 per cent. The weight was 562 lb per lineal ft for the 30-in. pipe in sections up to a mile in length, in 62 to 65 ft of water. The gas-carrying function of the line, of course, added a pressure problem different from that of oil lines. Gas pressure would be less than the outside water pressure, and compensation was necessary.

More than 2000 miles of oil pipe lines have been laid since Shell built the first one in Venezuela in 1917. Additional loops and gathering lines are continually being constructed so an exact mileage at any one time is difficult to pin down. In a year or two, when entirely new areas of exploration are expected to be opened, both the general totals and the geographical patterns of pipe line construction probably will be drastically changed.

Until recently, these patterns were fairly clearly defined into western and eastern areas. The western operations were synonymous with Maracaibo, site of the original Mene Grande discovery in 1914, and still the source of two-thirds of Venezuela's production. Both eastern and western shores, and, of recent years the lake floor itself, have been intensively developed and criss-crossed with gathering lines, to feed both the tanker fleet and the Shell and Creole pipe lines to the Paraguana refineries.

The eastern area is dominated by the Puerto La Cruz terminal near the town of Barcelona, but is wider spread than the western fields. It is diversified by production in several states, with at least four supplementary outlets for gas, crude, and petroleum products.

The possibilities for exploration have fallen in naturally with the topography

of Venezuela to divide pipe line construction in the manner outlined. Just south and east of Lake Maracaibo is the branch of the eastern chain of the Andes, the Sierra Nevada de Merida. The chain breaks in the Barquisimeto-Rio Cojedes Valley, which drains southeast into the Orinoco system. Farther east is the parallel system of the Maritime Andes, dominating the Valencia, Maracay, and Caracas population centers. The northward flowing Unare-Guaribe, and Aragua river systems mark the end of the mountains and point to the pipe line route to Puerto de la Cruz.

This great gathering center is fed by lines from the states of Guarico, Anzoategui, and Monagas. The longest, 157 miles, carries crude northeast from Las Mercedes field, while gas from the same region flows the much shorter but mountainous distance northwest of the Caracas district.

Three exceptions to the main current of petroleum from the fields of eastern Venezuela to Puerto de la Cruz are the Caripito, Tucupita, and Pedernales centers. The Caripito refinery in northeast Monagas, serviced by the San Juan River, tributary of the Orinoco, leading into the Gulf of Paria, receives all Quiriquire field production and some of the yield of the Jusepin field to the southwest, most of which goes southwest in the other direction to the Travieso tank farm, and then north to Puerto de la Cruz.

Tucupita, in the Federal Territory of Delta Amacuro, draws from the Temblador center, which includes Pilon and Uracoa, in southeastern Monagas. Straight north of Tucupita, at the mouth of several delta outlets, perches Pedernales on the Gulf of Paria, facing the land's end southwest point of Trinidad Island.

Future lines resulting from further exploration probably will follow the pattern already set. Barinas, the site of much current interest since Socony Mobil pioneered there 7 years ago and Sinclair has shown more recent successes, is technically in western Venezuela. But it is separated from Zulia state, the locale of the Maracaibo wells and farms, and Falcon, the state containing the Paraguana peninsula refineries, by the highest reaches of the Venezuelan Andes. The Cojedes River break to the rail and transportation center of Barquisimeto may become more significant and complicate the present east-or-west pattern.

The emergence of a new refining and shipping center is foreshadowed by the Venezuelan government's plans for Puerto Cabello, which will be the center of the projected petrochemical industry, less than 25 miles from Puerto Cabello and on the new railway line now being laid out between that port and Barquisimeto. An oil terminal is being planned for the Puerto Cabello region, and the natural gas for the Morón Works will be carried by a gas pipe line from the Guarico and Barinas oil fields.

The plant, on a 5000-acre tract of land, is scheduled for completion in 1957 and for full operation by 1960. Total cost, which will be borne exclusively by the Venezuelan government, is estimated at 100,000,000 bolivares ($30,000,000). Plans call for an initial yearly production of 150,000 tons of fertilizers, as well as chlorine, caustic soda, and dynamite for industrial use. The fertilizer plan fits in with the Guarico River irrigation project, which will help move population away from the northern centers and eventually establish further demand for newly located pipe lines for domestic natural gas service.

The Gas Project

The growing interest in gas adds to the pipe line picture directly in the way of recent construction and indirectly in that the increased industrialization of the nation based on native gas in-

evitably will have far-reaching effects on the domestic consumption of oil as well (current consumption already is more than 60,000 bbl a day, twice that of 1948), and, therefore, upon its production and transportation. Until recently, most of Venezuela's oil was exported, and most of the natural gas produced with the crude has been flared simply because of inadequate facilities for storage, transportation, and local utilization.

The Creole injection plant in Lake Maracaibo, which returns 137,000,000 cu ft a day, points to one significant future use of local gas. More widespread is the already felt effect of the first natural gas pipe line system in the country.

Begun in March, 1951, by Williams Bros. de Venezuela S. A. for Venezuelan Atlantic Transmission Corporation and Venezuelan Atlantic Refining Company, the system was completed in May, 1952. It was designed for a 70,000,000 cu ft per day capacity at an inlet pressure of 800 psi.

The system consists of 190 miles of main lines, 70.26 of gathering lines, and 50.89 of laterals. The system originates in the fields of central Guarico and moves northwest and west to terminals in Caracas, its port La Guaira, Arrecife, Santa Lucia, and Valencia.

The relatively high carbon dioxide content of the gas requires internal corrosion control. An inhibitor is injected in the wells and in the lines to protect the gathering system, and at the Guarico terminal of the main transmission line, a dehydration plant has been installed to reduce the water vapor content of the gas.

Cities that now use industrial gas facilities as a result of the new system are Ocumare del Tuy, San Francisco de Yare, Santa Teresa, Santa Lucia, Charallave, Caracas, Petare, Arrecife, La Guaire, Tejerias, El Consejo, Cagua, Turmero, Maracay, La Cabrera, San Joaquin, Guacara, and Los Guayos.

In 1952, an important gas line was constructed by Mene Grande and Creole from the Anaco gas regulator station to Puerto de la Cruz, 29.4 miles of 16 in. and 32.5 miles of 12 in.

Pipe Line Developments

Most noteworthy pipe line completion last year was the 45-mile line from Shell's Block 1 offshore field in Lake Maracaibo to the Palmarejo terminal. The capacity is 100,000 bbl a day. The job took three months and cost $9,700,000.

The previous big Shell venture was the 30-in. line, 163 miles long, from its Palmarejo terminal at the narrows of the lake to the refinery at Point Cardon at the southwest corner of Paraguana Peninsula. It was completed in the spring of 1952, and moves 235,000 bbl a day. The Carden refinery is Venezuela's largest, with a capacity of over 170,000 bbl a day.

Creole, Venezuela's largest producing company, increased the potentialities of the Amuay refinery on the west coast of Paraguana peninsula by adding a companion line in 1952 to the one already stretching from the Ule tank farm in the Bolivar coastal fields on the east coast of Lake Maracaibo.

Mene Grande, the Gulf subsidiary in Venezuela, depends mainly on the Oficin-Anaco, Anaco-Puerto de la Cruz and Travieso-Puerto de la Cruz pipe lines, which are operated jointly with Creole. A new 16-in. loop of the main Oficina-Puerto de la Cruz line was completed last year, extending southward from Anaco for approximately 18 miles and thence eastward for a distance of approximately 27 miles to serve the gathering stations of the North Nipa, Zeta, and Northwest Leona areas.

In addition, a new 10-in. lateral has been constructed between Anaco and the Santa Rosa field to handle the additional production anticipated from the operation of an extensive cycling project. This line is about 5½ miles in length and has a capacity of 38,000 bbl a day. ★ ★ ★

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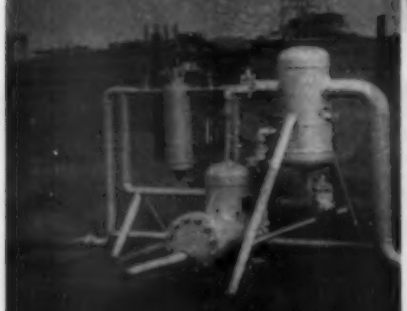
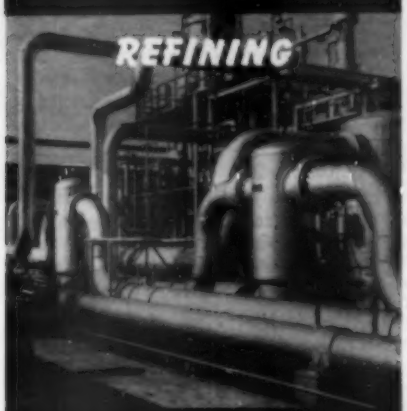
PRODUCTION



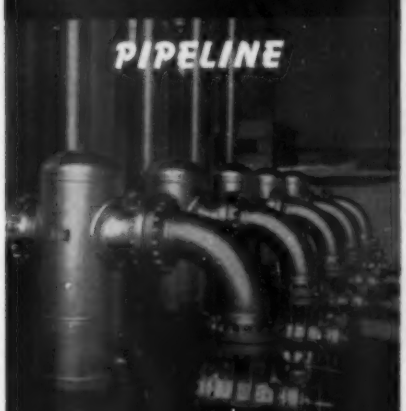
Pictured above is a Peerless Line Separator removing moisture from fuel to drilling rig.

REFINING



These two Peerless Line Separators are doing an efficient job of mist extraction in the Petrochemical plant in Kentucky.

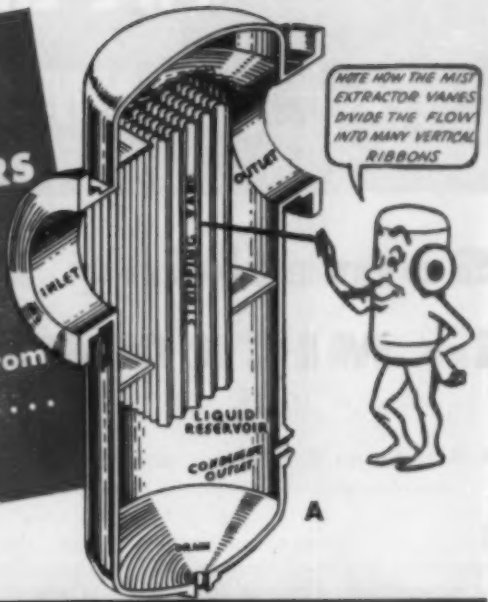
PIPELINE



FIVE Peerless Line Separators are shown above as they handle carry over from large scrubbers.

PEERLESS LINE SEPARATORS

Outstanding for the efficient extraction of liquid mist from gas or steam . . .



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Thousands of installations throughout the oil industry . . . production, pipeline, refining and petrochemical . . . prove the Peerless Line Separator principle to be one of the most outstanding methods available for the extraction of liquid gas, steam or air.

Drawing A above shows the arrangement of the vanes in the Separator. Drawing B is an illustration of the Peerless Principle.

The mist extractor combines the forces of impingement, centrifugal motion and surface tension to obtain its high efficiency. The path of the gas, etc., through the unit is constantly bending causing semi-violent turbulence and rolling of the gas against the walls of the vane. Impingement and centrifugal force combine to contact the droplets with the vanes, where they coalesce, and surface tension then causes them to cling to the vane's surfaces. Gravity and the impact of the gas steam then drive the droplets into the pockets where they roll down the vanes and out of the gas stream.

Through the Peerless method of mist extraction, the gas is stripped dry long before reaching the end of the vanes.

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D-105

P 615.635.1

Something New in MICROWAVE

Here's a first report on a new method of obtaining high reliability in UHF radio link systems, parallel path operation from single antennas through polarization

R. B. Hoffman, R. C. Ferrar, and H. A. French
Federal Telecommunication Laboratories, Nutley, New Jersey

THE use of duplicate communications equipment, in a standby arrangement, to minimize circuit outages due to operating equipment failure is common practice. Such a system requires, for operation at an unattended radio relay site, a suitably designed automatic switchover equipment to sense failure, analyze the type of failure, and act to switch the inoperative unit out of the circuit and replace it with the standby unit. This automatic switchover equipment represents additional circuitry in the operating system that is not only susceptible to failure in itself, but may also reach degrees of complexity and size comparable to the equipment it is to control. Additionally, some circuit time is lost during the switching interval. Such circuit interruptions are extremely undesirable when traffic includes remote operation and control functions, telemetering, teletype, etc.

A radio link system has been designed and developed by the Federal Telecommunication Laboratories (a division of International Telephone and Telegraph Corporation) that provides a high degree of traffic circuit reliability, eliminates switchover equipment, eliminates switching interruption, and features an interesting flexibility of equipment operational arrangements.

This novel system design has been incorporated in the 1850-2700 Mc PTM UHF link for multi-channel telephone communications manufactured by the Federal Telephone and Radio Company, the manufacturing division of IT&T.

The radio circuit, for each direction of transmission, is made parallel path from pulse input to pulse output. Operation is on a single microwave frequency. Duplicate transmitting and receiving radio equipments are employed and the propagation paths are kept separate by the use of orthogonal polarizations of transmission. A single parabolic reflector with a dual polarization horn feed is used.

First commercial installation of equipment operating in the parallel path system will be accomplished this spring with the extension of the microwave communication system of the Sinclair Pipe Line Company from western Pennsylvania into Ohio. The system will include five radio hops between East Pittsburgh, Pennsylvania, and Clinton, Ohio.

A simplified block diagram of the parallel system is shown in Fig. 1. The system basically consists of two separate microwave circuits for a given direction of transmission with video inputs and video outputs connected in parallel. Both transmitters and both receivers in the radio circuit are utilized in full-time operation on the same R-F frequency to carry the communication simultaneously over the parallel paths. The R-F propagation paths are separated on a polarization basis. The antennas provide two orthogonal polari-

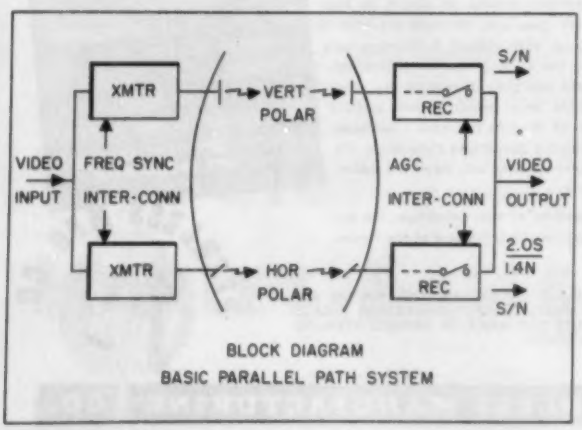


FIG. 1.

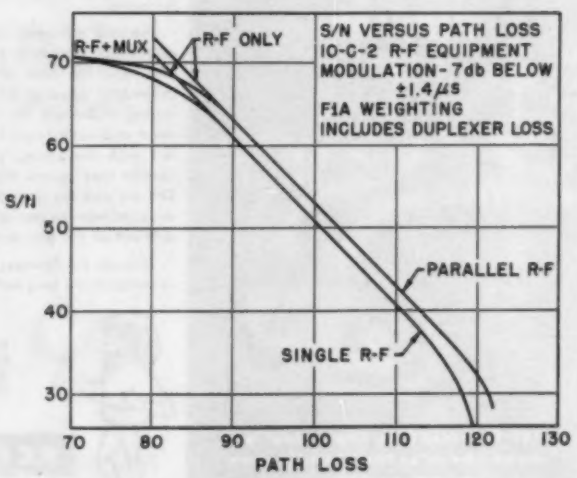


FIG. 2.

MICROWAVE COMMUNICATIONS:

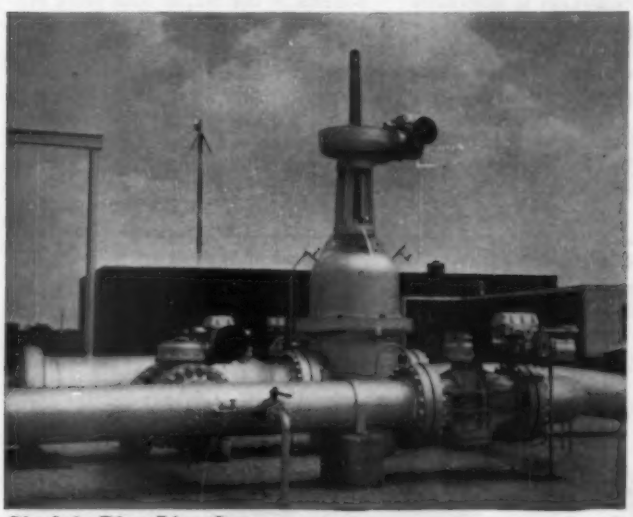
Public Service Company of Indiana, Inc.

Microwave radio aids in controlling supply of electricity for the state of Indiana. Four branches of a G-E Microwave system—combining voice and telemetering channels—originate at utility headquarters in Plainfield. From this hub regional demands are controlled according to local needs. Load control information obtained by remote control telemetering is analyzed, then transmitted to generating stations in necessary areas. Entire electrical power system is linked solidly by microwave radio.

Busy Tower

Antenna receives, transmits, or relays voice or telemetering signals. Antennas like these link headquarters with generating plants and sub-stations over a wide area.

P.S.I.'s microwave network provides utmost dependability because of standby equipment, fail safe feature, and because equipment can be concentrated at specific locations where it can be fully protected and easily maintained.



Sinclair Pipe Line Company

Microwave radio helps Sinclair coordinate flow of crude oil and oil products over many states—even turns pumps on and off. 7 voice, 4 telemetering channels link Cushing, Oklahoma and East Chicago, Indiana. Another channel permits remote control of 16 VHF radio base stations along the line which provide communication between over 100 radio-equipped vehicles and any company office in the microwave system. System is capable of providing up to 12 additional channels as needed.

Are microwave circuits your answer, too?

It depends.

What kind of service do you provide, how do you do it?

Let's assume that instant control and coordination of many functions, over long distances, are vital to your needs. Then you *should* investigate microwave because it is dependable, economical, and inexpensive to add additional circuits.

The services shown here *need* dependable voice and signal circuits. One controls the flow of crude oil and oil products over many states. The other uses microwave to link electric power facilities throughout one state.

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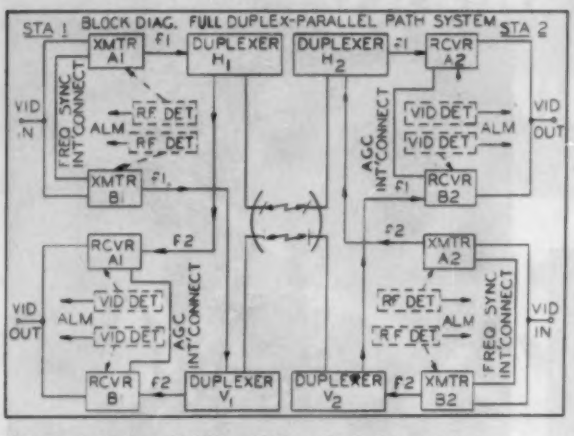

FIG. 3. A high reliability UHF radio link system.

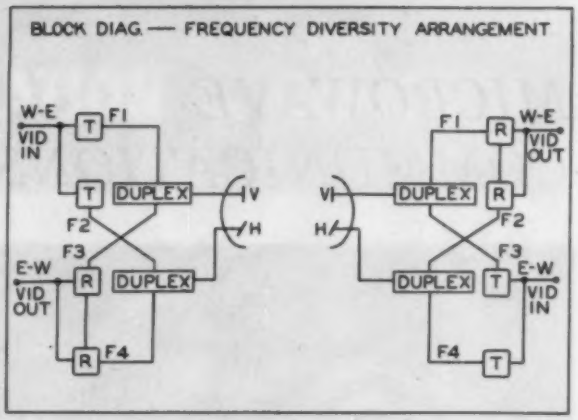

Fig. 4. A high reliability UHF radio link system.

zations of transmission, by means of a square waveguide, dual polarization horn feed to the circular parabolic reflector.

The crystal-controlled R-F driver units of the paralleled transmitters are synchronized to maintain identical output frequency from both units. The parallel pulse input connections of the transmitters are fed from a common video source, and the pulse output connections of the paralleled receivers feed a common 70-ohm load. Additionally, the AGC busses of the receivers are interconnected. Separate monitoring and alarm facilities are contained in each transmitter and receiver, permitting evaluation of performance of each unit while in operation.

A high degree of operating reliability is achieved with this "parallel-path" operation. Except for power line, no active circuits are common to both paths. A failure of the equipment in one path will cause its disconnection at the receiver output, and the traffic will continue to be carried by the second path.

The lack of circuit interruption and high degree of reliability of the system is obtained with full-time operation of duplicate equipment. This type of operation may be thought to be rather extravagant of tube life. When other, rather important, restrictive requirements of operation are considered, it is seen that such is not the case. Present operation in a standby-switchover arrangement must be practiced with the standby equipment either completely off or full powered.

Standby with only filaments on will result in considerably shortened tube life, due to development of cathode interface.

Operation with "cold" standby results in a further increase in circuit interruption time due to switching which more than likely already is intolerable in traffic circuits that carry remote operation control functions.

The practical alternative, then, is to operate standby with filament and plate power applied. This full powered operation minimizes, but does not eliminate, the time period of switching interruption. Furthermore, all tubes are used in full-time operation.

Obviously then, when operation with maximum reliability and no circuit interruptions are important factors, the parallel path arrangement compares favorably with the conventional standby-switchover arrangement on the point of tube utilization. Additionally, no circuit interruptions are suffered with the parallel arrangement.

Under normal operating conditions, up to 3 db increase of S/N relative to the S/N obtained from a conventional single path arrangement is realized at the parallel system output due to the synchronous nature of the PTM subcarrier and the nonsynchronous characteristic of the noise. This is derived from the fact that the signal components in the output load being synchronous will add algebraically, while the noise components from the two receivers will add on a power basis. Therefore, the total combined signal output will be 6 db greater, and the combined noise component will be only 3 db greater than either receiver alone.

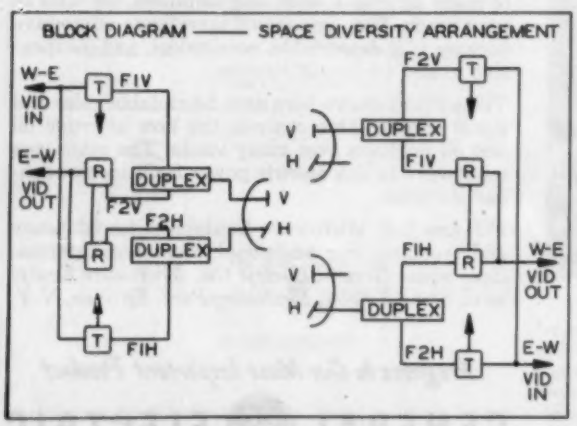

FIG. 5. A high reliability UHF radio link system.

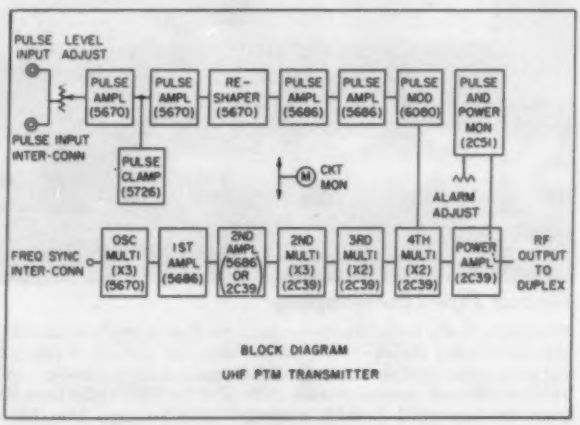

FIG. 6. A high reliability UHF radio link system.

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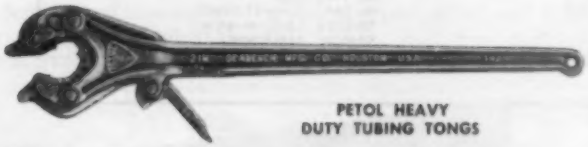

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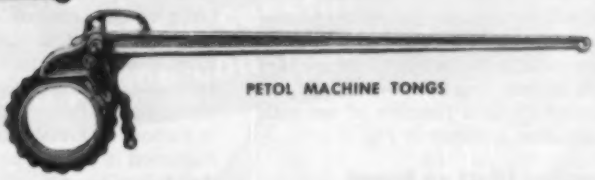

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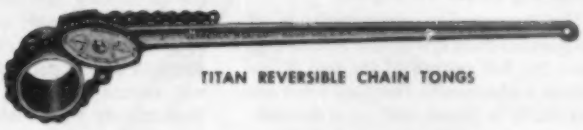

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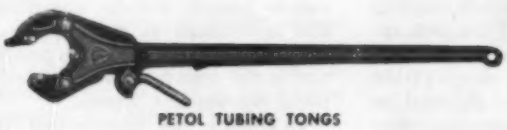

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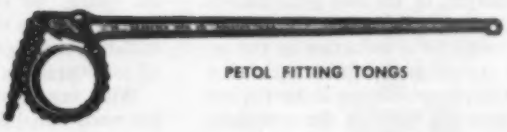

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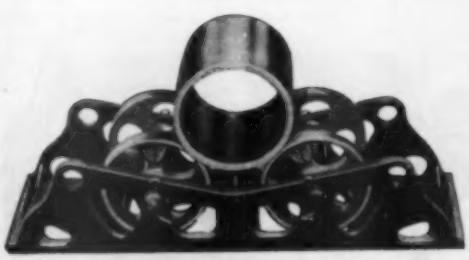

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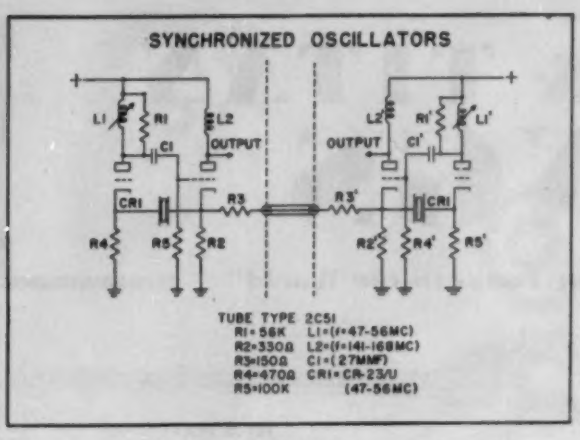


FIG. 7.

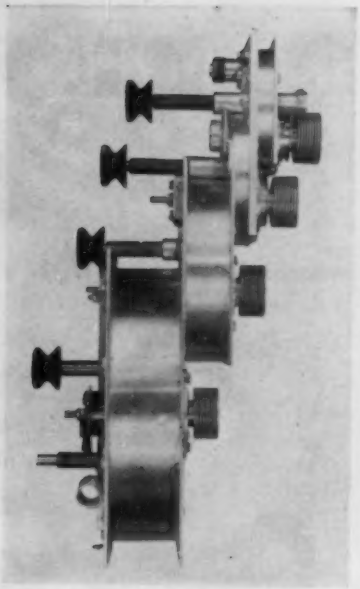


FIG. 8. Transmitter R-F cavities.

When failure of one path occurs, resulting in the disconnection of a receiver from the output, this increase in S/N will be lost. The resultant S/N will still be equal to that of a conventional system. A plot of typical signal-noise ratio at the output of the parallel path system, together with single receiver S/N, as a function of net path attenuation is shown in Fig. 2.

Coupling Effect on Signal

The propagation characteristics of this parallel-path system are interesting. Since the R-F output of the two transmitters is identical in frequency but not necessarily in phase, and since the radiated energies of the two polarizations will not necessarily be in phase, the net effect could be a reduction in the received signals at the following station due to wave cancellation if there is any cross-coupling between the orthogonally polarized waves at the receiving antenna.

Theoretically, there is no coupling between the two polarizations at the antenna. However, a practical antenna installation will exhibit some degree of cross-coupling due to asymmetries in antenna structure, parasitic reradiation from supporting structures, and the like.

A center-fed horn-driven parabolic reflector antenna produces a minimum cross-coupling. The magnitude is negligible for any practical consideration, it being of the order of 35-40 db for a good practical design. Additional sources of cross-coupling are in the anomalies of propagation, such as scattering and twist.

Various degrees of cross-coupling, expressed in db, can be shown to yield the following net effects. A 20-db coupling will result in a reduction of approximately 1.0 db in the signal strength of one path. A 10-db coupling will reduce the signal of one path approximately 3 db. Field experience and the results of several propagation studies indicate that in a practical installation the degree of coupling due to all considerations will be -20 db or less.

With any degree of cross-coupling, the worst signal degradation effects are obtained under conditions of receiver failure in the path in which the received signal has increased due to the additive component of intercoupling. Under these conditions and with the maximum cross-coupling of -20 db expected in practice, the worst effect will be of the order of 1 db reduction in received signal amplitude of the remaining path.

In two-way link operation, full duplex is used on each polarization with a frequency separation of about 50 Mc. Fig. 3 shows a block diagram of the equipment arranged in the parallel path system with full duplex. The return circuit to provide two-way communication is obtained by duplexing transmitters and receivers on each polarization in the same manner as in conventional two-way link systems.

Examining the transmission path from Station 1 to Station 2, it is seen that the equipments involved in the transmission circuit are Transmitters A^1 and B^1, Duplexers H^1 and V^1, the dual-polarization antennas at each station, Duplexers H^2 and V^2, and Rereivers A^2 and B^2. The transmitters at Station 1 are fed the same video signal and are synchronized. The RF outputs of both transmitters are fed through the duplexers to the two polarization inputs of the antenna; Transmitter A^1, to the input providing horizontal polari-

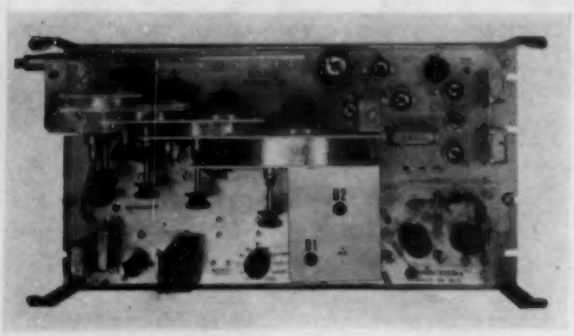


FIG. 9. UHF PTM transmitter—front view.

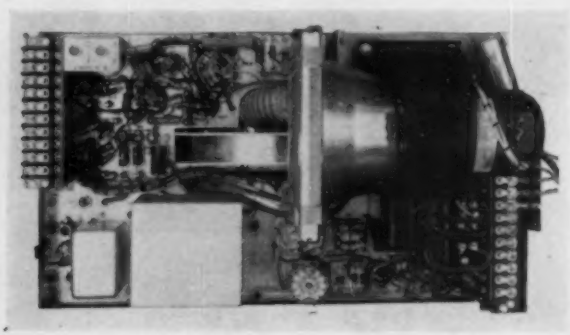


FIG. 10. UHF PTM transmitter—rear view.

zation, and Transmitter B^1, to the input providing vertical polarization. The received signals on each polarization, at Station 2, are fed through duplexers to the receivers, with Receiver A^2 receiving signal from Transmitter A^1 and Receiver B^2 receiving Transmitter B^1. The video outputs of the two receivers are connected in parallel to feed a common load.

Monitoring and alarm facilities are provided in each transmitter and receiver. The video output circuit of each receiver is interconnected with the alarm circuitry by means of a relay so that the output of the receiver in a path which has failed is disconnected from the common load. This prevents the faulty path from adding noise to the traffic circuit.

The radio equipment can be readily operated in space or frequency diversity with a minimum of additional components. Fig. 4 and 5 show a block diagram of equipment arrangements for diversity operation. To operate in frequency diversity, all that is necessary is to operate the two parallel paths on different RF frequencies, as shown in Fig. 4. Between the 1850-2000 Mc and the 2450-2700 Mc bands, frequency separations up to 840 Mc are practical. This is adequate for effective frequency diversity operation with reflection and refraction path differences of about 0.3 ft or greater.

Such operation will protect against fades of the signal interference type in the majority of practical link installations and for the most of the adverse propagation conditions which might be experienced.

Fig. 5 shows a block diagram arrangement for operation of space diversity. It should be noted that only three antennas are required for full space diversity. One station utilizes a single antenna with equipment connection the same as for normal operation. The second station employs two spaced antennas, one connected to equipment for operation on horizontal polarization and the other connected for transmission on vertical polarization.

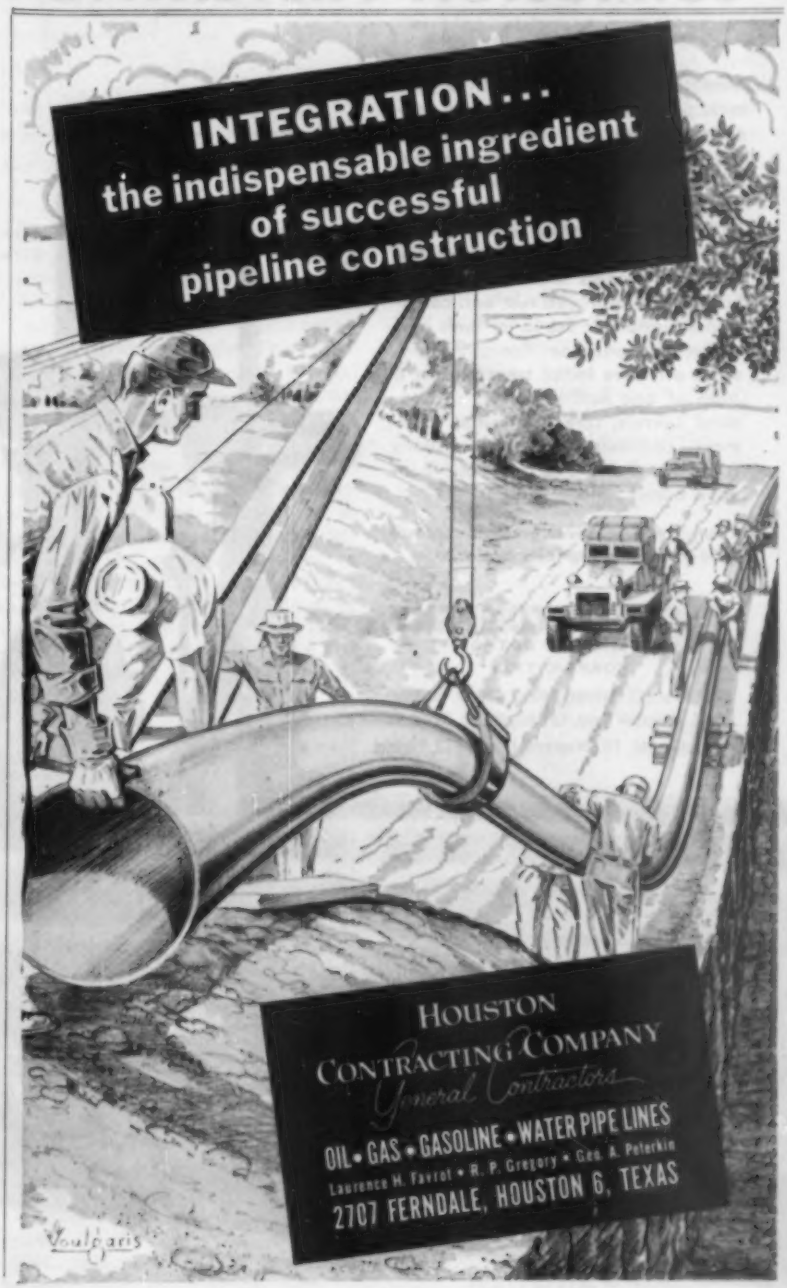
In this manner, space receivers are obtained at the second station providing space diversity arrangement, while spaced transmitters at this station provide the space diversity for the return path. Of course, paired transmitters and receivers for each direction of transmission operate on the same frequency as in normal arrangement.

When operating in space diversity, the transmission path lengths for the two polarizations obviously will be different because of the net difference in length of antenna transmission line in the two polarization paths. Therefore, it is necessary to artifically delay the pulses in the shorter path. Provision for effecting this is made by the incorporation of a step-adjustable delay line in each receiver.

Some unique features of equipment design represent successful design attempts to provide extreme simplicity of alignment and operation, as well as low incidence of component failure. In the first place, conservative rating design is used throughout. Secondly, microwave circuits have been designed to eliminate intricate and critical mechanical characteristics and minimize alignment controls. Examples of this are seen in the duplexer and transmitter microwave circuitry. The duplexer comprises simple, synchronously tuned elements utilizing iris-coupled, quarter-wave tuned transmission-line filters. The transmitter microwave stages utilize integrally-coupled radial transmission-line cavities operating in non-symmetrical modes.

The transmitter is a crystal-controlled, continuously tunable unit. The frequency bands 1850-2000 Mc and 2450-2700 Mc are covered by two chassis units. The receiver is a conventional single superheterodyne circuit utilizing a 2043 coaxial cavity local oscillator, transmission-line filter preselection, crystal mixer, and a 30 Mc IF.

The transmitter unit is shown in



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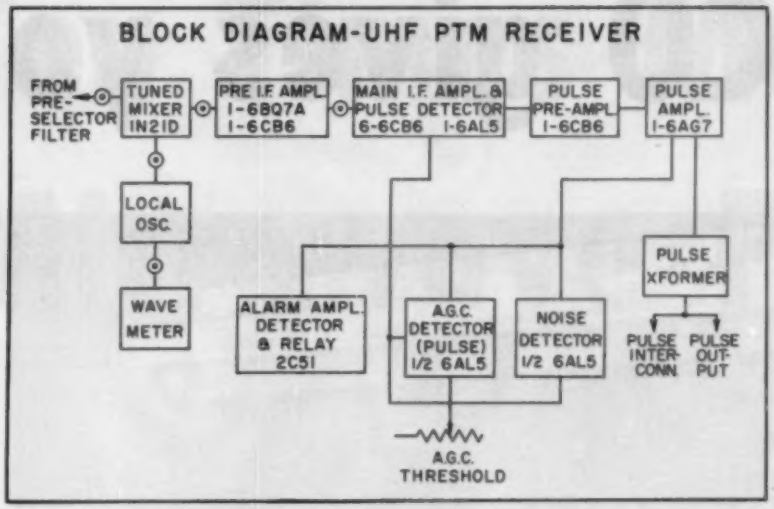

FIG. 11.

block diagram form in Fig. 6. The circuitry can be functionally divided into the modulator-reshaper section; the exciter section; and monitoring, alarm, and alignment facilities. The exciter section consists of a crystal-controlled oscillator-multiplier, operating at base frequencies of 51.5—55.3 for the 1700-2000 Mc band, and at 51.1 to 56.2 for the 2450-2700 Mc band. Following the oscillator are several stages of amplification and frequency multiplication, and a power amplifier. A total multiplication of 36 is used for the low band and 48 for the high band unit. Conventional lumped constant circuitry is used in stages operating below 450 Mc. Above this frequency range microwave cavity techniques are used.

The modulator-reshaper section includes several stages of video amplification and pulse reshaping circuits. This section operates to accept video pulse signals, amplify, and reshape them to the required characteristics. The output of the modulator-reshaper section operates to key the final RF multiplier stage prior to final RF power amplification. The pulsed RF output from the power amplifier stage is monitored by a circuit which detects its presence and amplitude and is used both for alignment purposes and alarm circuit operation.

The alarm circuit output is contained in two pairs of relay contacts that close upon failure. These contacts are brought out to external terminals on the transmitter and provide the facilities by which, with proper interconnection, both local or remote alarms can be initiated. The alarm circuits of two transmitters operating in the parallel-path circuit can be interconnected so that the failure of either unit alone will produce a second alarm while a failure indication from both transmitters, indicating input signal failure, will produce a primary alarm.

All the internal circuit points necessary for alignment and checking of operation are monitored on an integral front panel meter through a selector switch.

As described in the system outline, when two transmitters are operated in the parallel path system it is necessary that the RF outputs of both be at exactly the same frequency. This is accomplished by an interconnection of the crystal-controlled oscillators as shown in Fig. 7. By a combination of a-c and d-c coupling between the cathodes of the cathode follower sections of the oscillators, synchronization is accomplished.

Summarizing this synchronized oscillator operation, both transmitter-exciter sections are driven by the synchronized oscillator signals of the two driving units. Should the crystal oscillator of one transmitter fail, the crystal oscillator in the other unit takes over and the second transmitter operates independently of the first, and at its own crystal frequency. In this case, of course, there is no RF output from the failed unit. In the case of any other failure in the first transmitter, such as in the latter multiplier or amplifier stages, there would be no RF output from it, but the frequency of the second transmitter would still be determined by the synchronized crystal oscillator. Conversely, any failure in the circuits of the second transmitter will merely cause loss of its RF output and would have no effect, of course, on the first transmitter that would continue to operate and carry the traffic.

As mentioned previously, the transmitter design contains features that represent successful attempts to provide extreme simplicity of alignment and low incidence of component failure. In addition to conservative rating design of all tube circuits, microwave circuits have been designed for ultra-simplicity of alignment and operation. All the frequency determining circuits in the transmitter have single-control tuning. The entire tune-up procedure is a simple, sequential, peak-tuning operation. The microwave circuits employ a unique design of integrally-coupled radial transmission-line cavities.

Shown in Fig. 8 is the cavity assembly for low band operation. A front view photograph of the transmitter, with protective covers removed, appears in Fig. 9 and clearly shows these cavities stretching diagonally across the chassis. The modulator-reshaper circuits are located in the upper right-hand portion of the chassis and the low frequency crystal-oscillator-multiplier section in the lower right. Fig. 10 shows a rear view of the transmitter, and indicates the high degree of accessibility to components maintained in the layout.

The receiver block diagram is shown in Fig. 11. The duplexer for the radio set is located on a separate chassis and indicates the preselector portion of the receiver. This duplexer comprises two filter elements T-coupled to the antenna feed, and provides a transmitter input branch and the receiver preselector

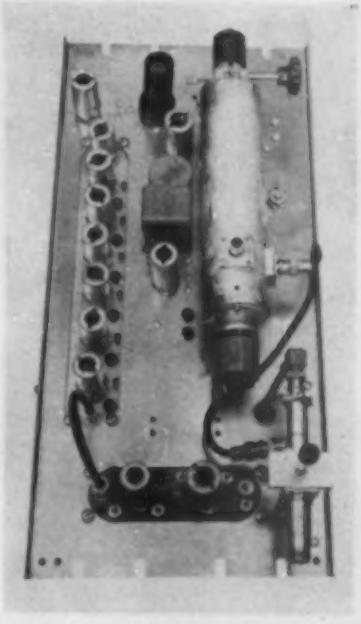

FIG. 12. PTM receiver.

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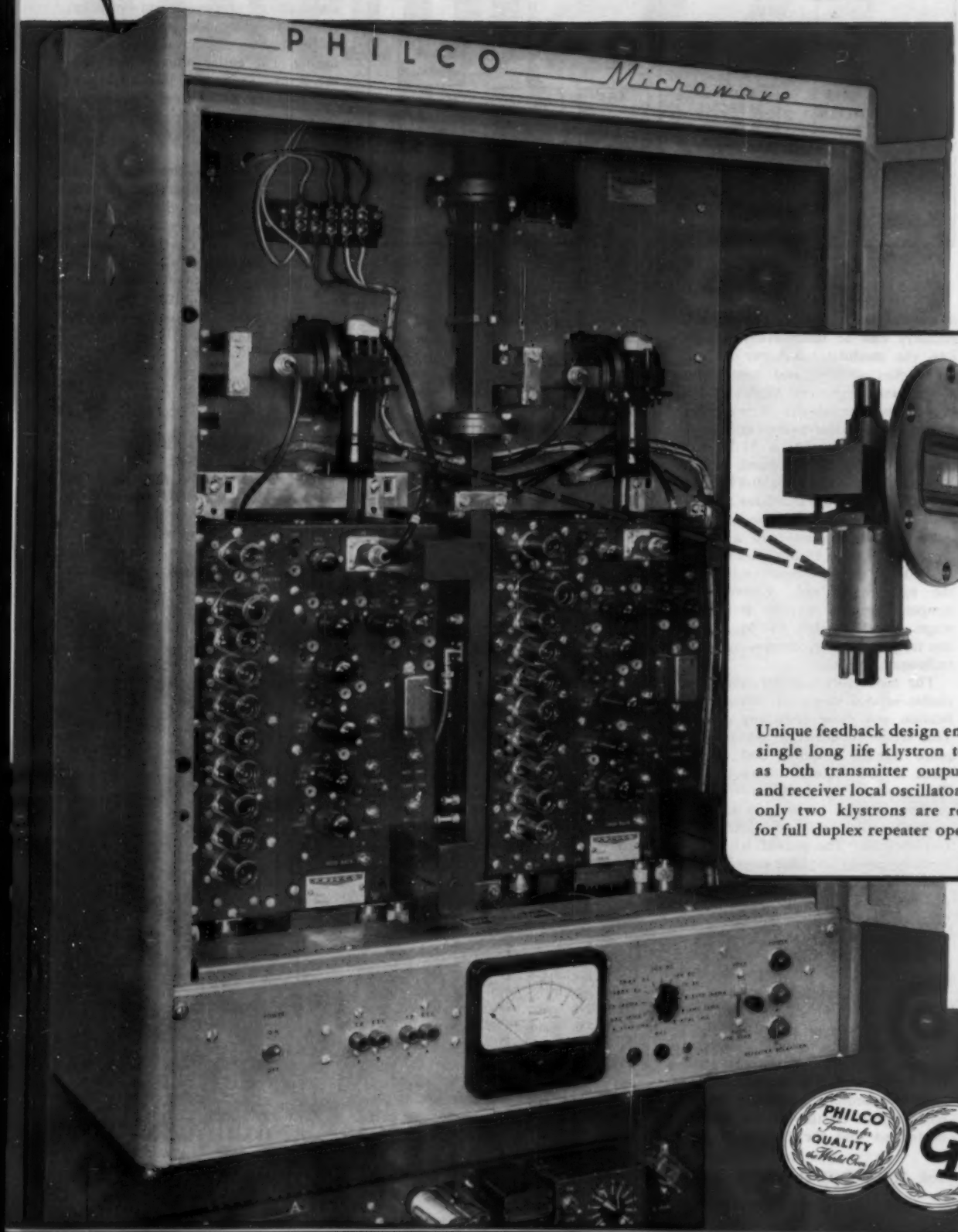

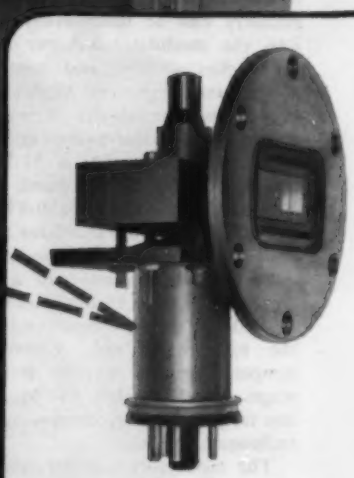

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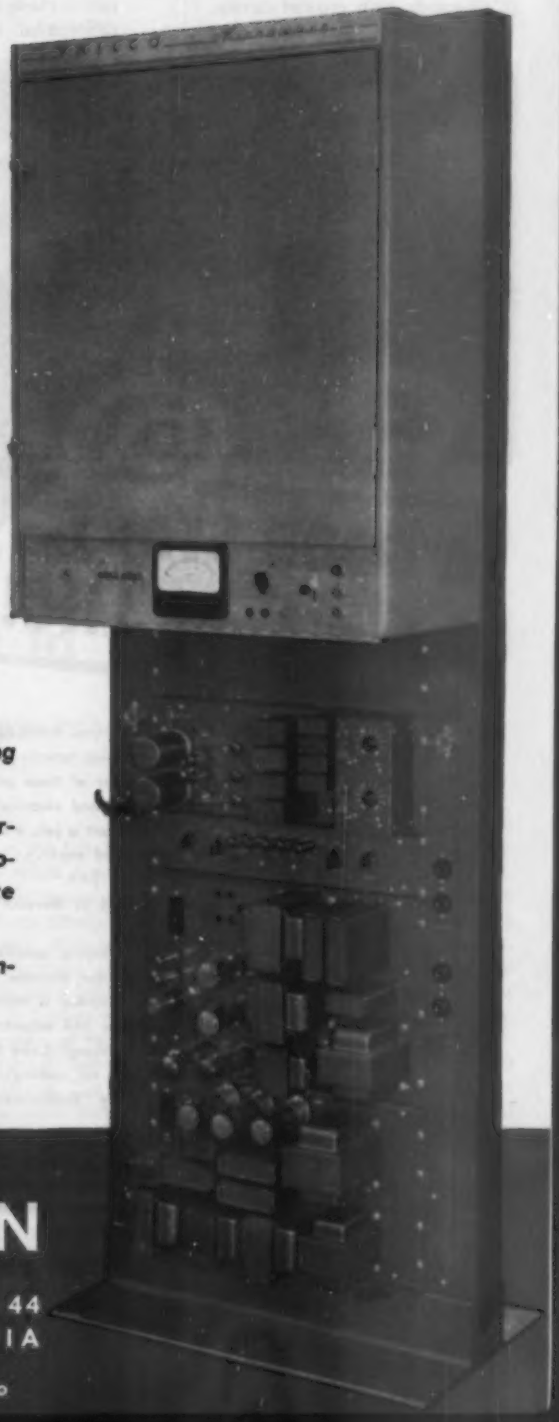

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branch. Each of the branch filters in the duplexer consists of simple synchronously-tuned elements that utilize iris-coupled, quarter-wave-tuned, transmission-line filters.

The mixer is a cavity-tuned element using a IN21D crystal. The receiver IF operates at 30 Mc and is separated into two sections: (1) a preamplifier with a low noise cascode input circuit, and (2) the main IF that includes the video detector. The video amplifier section includes pulse amplifiers and the S/N alarm detector and AGC detector circuits. The local oscillator is a type 2C43 triode with coaxial cavity.

As mentioned previously, provision is made for interconnection of the two receiver AGC busses for operation in a parallel-path system or for diversity operation. For the normal parallel-path operation, a "moderate control" AGC interconnection is made. This interconnection is designed to assure maintaining parallel operation of the receivers over a range of moderate (any 6 db) differences in received signal strength, while forcing "cut-out" of the receiver with the poorer signal strength under conditions of large (say 15 db) disparities of signal. When operating in diversity, full AGC level interconnection is made to provide 3-4 db diversity differential, i.e., a 4-db difference between the signal strengths of the two receivers will cause the weaker signal receiver to cut out. Within that differential, both receivers will operate in parallel. Diversity control is effective over the range of input signals from threshold to saturation of the receivers.

Two separate video output connections are provided to permit conventional single-receiver operation or parallel-path operation of two receivers into a common 70-ohm load. Separate AGC interconnection terminals are provided for operation in the parallel-path system or in diversity.

A photograph showing the front view of the receiver with protective cover removed appears in Fig. 12. The mixer assembly can be seen at the top of the chassis, and the local oscillator in the center. The pre-i-f amplifier is situated along the right-hand edge of the chassis, and the main i-f is located along the bottom edge of the chassis. The video amplifier and control circuits can be seen in the upper left-hand area of the chassis. A rear view of the receiver is shown in Fig. 13. Here again can be seen the accessibility provided for maintenance and repair when needed.

The parallel-path PTM link system utilizing the radio equipment components just described operates with a maximum System Figure of Merit (F1A) of at least 153 db.

The System Figure of Merit is defined as the sum of the net operating path attenuation expressed in db and the channel S/N obtained with the system operating at that path loss, also expressed in db.

The maximum Figure of Merit will be obtained between the values of path attenuation at which saturation and threshold conditions are evident. Therefore, for example, if the net propagation loss (the sum of line losses, free space propagation losses, less the antenna gains) between the transmitter RF output terminal and the receiver RF input terminal is 100 db, then the telephone channel S/N will be at least 53 db. System "drop-out" for this system occurs at about 15 db below maximum Figure of Merit. Thus, for a 40-mile path with 10-foot parabolic antennas, a fading margin of approximately 50 db to drop-out is available.

The equipment chassis are designed for standard 19-inch panel mounting. Equipment can be mounted in an enclosed cabinet or in an open relay rack. A front view of the complete parallel-path equipment for a terminal is shown with and without protective covers in Fig. 14 and 15.

All operating controls are available on the front panel on all units. Operator protection devices are included to avoid accidental contact with compon-

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D-116

ents or points of high potential. The transmitter and power supply front protective covers are interlocked. Areas of exposed high voltage points on the rear of all chassis are covered by protective Lucite plates.

Summarizing the system operation, a number of the advantages compared to a conventional system with switchover accrue to the parallel-path system. These are:

1. Elimination of all switchover equipments or circuits which not only are susceptible to failure in themselves, but may also reach a degree of complexity and size comparable to the equipment they are to control.

2. A failure in one of the units will not interrupt traffic. No traffic time is lost as a result of switching to standby.

3. Increase reliability in that both operating equipments are continuously monitored for condition of operation. A failure cannot occur without the initiation of alarm so that the failure is recognized and repairs can be made as soon as practical.

4. Operation in either space or frequency diversity arrangements, if required, with a minimum of additional components. Space diversity operation is obtained with no additional radio equipments and only three antennas, as compared to extra receivers and four antennas required in a conventional system. Frequency diversity operation requires no additional equipment but only retuning to a different operating frequency for one of the paths. * *

Take time to relax, think, listen and learn at the

11th Annual Short Course in Gas Technology

It's one of the gas industry's finest technical meetings

Are your fellow workers getting on your nerves? Do salesmen bother you? Is your secretary becoming temperamental? Is the boss getting dumber by the day? Don't you have time to read about the new thingamagig that might save your company millions of dollars?* If most of the answers are yes, chances are you need to take time for *relaxing, thinking, listening and learning*. And if you are in the gas business, there's no better place than the Southern Gas Association sponsored Annual Short Course in Gas Technology starting May 30 and running through June 1.

This school is one of the industry's most effective technical meetings, yet its pace is unhurried and pleasant. It is held on the colorful campus of Texas College of Arts and Industries in Kingsville, Texas, just 100 miles from the Rio Grande border. Palm trees, Spanish architecture, and the Latin-American atmosphere lend a color to the three-day school that gives you a slight feeling of guilt as though you were on a stolen vacation. From registration to the farewell barbecue held on the fabulous King ranch nearby, the school is a welcome relief from the usual high-speed centrifugal hotel-bound technical meetings. There's time for quiet chats with men from other companies who may have similar problems to your own. And amid such a setting, friendships form swiftly.

The authors and speakers are brainy and among the top men in their field. The school's roster of speakers during its ten-year history reads like Who's Who in the Gas Business. As a matter of fact, the school has at times served as a sounding board for some of the industry's most important technical innovations. The panel discussions held on the third day are for the most part questions and answers; and engineers and supervisors can enlist not only the aid of the panel in solving a pressing problem, but also the whole roomful of gas men.

So if you need to recharge your battery, pick up new ideas and perhaps get a little aid in solving some technical problem, send for a registration blank.

* In *The Petroleum Engineer*, of course.

PIPE LINE PERSONALS

Ross Mitchell, district pipe line foreman for the Ohio Fuel Gas Company since 1946, has been promoted to pipe lines superintendent of the company's southeastern division. In his new post, Mitchell will be in charge of construction and maintenance of Ohio Fuel pipe lines in the division, which comprises 21 counties in southeastern Ohio, with offices in Athens. Mitchell replaces **Bruce Beal,** who retired recently.

George A. Whitten has been appointed assistant to the manager and in charge of construction and maintenance in the pipe line department of Texas Gas Corporation. **Jesse Bertrand** has been named superintendent of operation. **Donald G. Hall** has been appointed field foreman in the operations section of the Winnie area. **Ed Shettle** and **Clovis Bernard, Jr.** are manager and chief engineer, respectively, of the pipe line department.

There's a sense of security when a Sheehan "spread" is tending the job . . . an assurance that only the most efficient in equipment, methods and manpower is being used to complete your project *on time.*

Your project, whether large or small, will receive our immediate and reliable attention.

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Louis M. Miller, assistant chief engineer for Sun Pipe Line Company, has been appointed treasurer to succeed the late **Russell W. Bowers.** Miller also becomes treasurer of Sun Oil Line Company of Michigan and Sun Pipe Line Company of Illinois as well as assistant treasurer of Sun-Canadian Pipe Line Company, Ltd. Additionally, he will be manager of operations for the product lines department of Sun Pipe Line Company.

Arthur B. Allyne, Houston, Texas, has been elected a vice president of the Pacific Northwest Pipeline Corporation. Allyne has been project engineer for Fish Northwest Constructors, Inc., which has had the task of engineering and constructing the Pacific Northwest system. Having participated in the management of the construction of Pacific Northwest's project.

Charles E. Brooks, Pittsburgh, has been appointed production and storage engineer for New York State Natural Gas Corporation. Brooks will expedite all engineering investigations pertaining to storage and storage design.

R. E. Hruska

D. C. Thomas

Ralph E. Hruska has been elected secretary of Service Pipe Line Company. He succeeds **W. O. Middaugh,** who resigned. **Donald C. Thomas,** assistant manager of Service Pipe Line's procedure department, was elected assistant secretary.

All other officers of the company were re-elected at a recent board meeting. They are: **J. L. Burke,** president; **J. L. Shoemaker,** financial vice president; **J. R. Polston,** vice president — operations; **R. J. Andress,** executive vice president; **J. R. Fredenberger,** treasurer; **C. W. Keith,** comptroller; **W. E. Taylor,** assistant treasurer, and **J. L. Donovan,** assistant comptroller.

N. C. McGowen has been elected to the newly created post of chairman of the board of the United Gas Corporation. **Ed Parkes** has been elected president of two of the corporation's subsidiary companies, United Gas Pipe Line Company and Union Producing Company. McGowen will continue to serve as president of the corporation, and will also be chairman of the board of the two subsidiaries.

The company has also announced the promotion of **A. D. Greene** as executive vice president of United Gas Pipe Line; **W. H. Spears** as executive vice president of Union Producing, and **L. V. Tracht** as vice president of United Gas. Tracht will continue to serve as treasurer of the parent company.

Richard H. Cook has joined Warren Petroleum Corporation, gas division, as district representative. Formerly he was gas supply manager with the Houston Pipe Line Company.

Joseph W. Parys has been named superintendent of engineering contracts for Natural Gas Pipeline Company of America and its affiliates. Parys has been with NGPL for seven years, working as a draftsman and engineer before joining the contracts department. Parys succeeds **Charles G. Freund,** who has been appointed administrative assistant to the secretary-treasurer of the company, **George P. Garver.**

George F. Tongue has been named manager of coordination and office administration by Mid-Continent Pipe Line Company at Tulsa, Oklahoma. **Clinton A. Sayles** has been named assistant to the chief engineer, and **Charles D. Pass** has been named district engineer to succeed Sayles.

Frank Kalbaugh has been selected by Southern Pacific Company to be general manager of its new subsidiary, Southern Pacific Pipe Lines, Incorporated. Previously with Southern Pacific's Salt Lake division, he left in 1953 to become manager of the government-owned Alaska Railroad. At the conclusion of that service last April, he was presented the U. S. Department of Interior's Distinguished Service Award by Secretary Douglas McKay.

Frank Kalbaugh

James R. Shipley has been named assistant to the manager of the transportation department of Standard Oil of Ohio. He will also be in charge of the adminstrative section. Shipley has just returned from Europe where he has been on leave for the past year as chief of the petrol, oils, and lubricants section of the North Atlantic Treaty Organization. **Henry W. Pattison,** who has held the jobs awarded Shipley, is now general superintendent in charge of all pipe line and marine operations. **Charles E. Curry,** general superintendent of operations, has been named chief engineer in charge of all design and construction of transportation facilities.

David W. Dolson has been named manager of the crude oil procurement and sales department of Leonard Crude Oil Company. Dolson was formerly vice-president in charge of crude oil procurement for Mid-West Refineries, Inc. **William "Bill" Elliott,** who served for five years as field representative for Simrall division, was appointed assistant to Dolson and chief scout. **Harold Gooseman** and **Arthur Justin** were named field representatives serving under Elliott. **John C. Horning** was named manager of field operations. Horning was formerly assistant manager of Leonard Pipe Line Company. **Gerald Watson** was named assistant manager of field operations. He was previously acting superintendent and engineer for Simrall division.

John C. Boehm is the new assistant personnel director for Transcontinental Gas Pipe Line Corporation, Houston, Texas. Boehm has been with Transco since July of 1950. For some time he has been superintendent of the natural gas transmission firm's compressor Division 3 in Charlottesville, Virginia.

CROSE . . . LINE TRAVELING

COATING & WRAPPING MACHINES

THE FINEST ON THE LINE BECAUSE OF IT'S SPRAY-RING APPLICATOR

Uniform Coating Precision Wrapping
Coats Bends or "Egged" Pipe

More contractors use CROSE machines because they have all the features required for most trouble-free, highest quality performance. Available in sizes that handle pipe 2" to 36".

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▸ **Wesley Embry** has been promoted to general manager by Modern Welding Company, Incorporated, Owensboro, Kentucky. He joined Modern Welding in 1938 and most recently served as general superintendent of the pipe line division.

▸ **James N. Fuquay** has been named assistant chief engineer for Sun Pipe Line Company's crude lines department, Beaumont, Texas. Other appointments in that department are: **Jesse D. Duplissey,** formerly assistant superintendent succeeds Fuquay as area superintendent at Corpus Christi, Texas. **Charles W. Gibson,** formerly district foreman at Snyder, Texas, advances to assistant superintendent to succeed Duplissey. Assuming Gibson's former duties at Snyder is **Rupert Short,** previously district foreman at Seabreeze, Texas.

▸ **Robert L. Bowman,** manager of construction for Bechtel Corporation's pipeline division, has been elected a vice president of the affiliated Bechtel International Corporation. Bowman has supervised the construction of some of the firm's major pipeline projects, including the Trans-Arabian pipe line across Saudi Arabia in 1947-49, the Pacific Gas and Electric Company's 34-in. high pressure gas transmission line from Topock to Milpitas, California, in 1949-1951, and the Lakehead pipe line across the Straits of Mackinac in 1953-1954.

R. L. Bowman

▸ Creation of a new department and appointment of two new department heads have been announced by Panhandle Eastern Pipe Line Company. The geological section of the land and lease department has been given full status as the geological department, with **J. E. Curry** as its head. All geophysical and geological functions of the company will be administered under his supervision. Other new appointees include **T. J. Kirkpatrick** as superintendent of measurement. He replaces **F. C. Walters,** who is now on leave of absence due to illness. **Joe Tiner** has moved up to the assistant superintendent job in measurement. **R. S. Heusel** takes Tiner's place as measurement engineer, operations. **T. F. McEntire** replaces Heusel as measurement engineer in charge of chart calculator and office procedure.

Paul L. Davis has been named superintendent of the land department of Panhandle Eastern. The right-of-way department, which has been under the supervision of Davis, has been incorporated into the land department. **A. R. Epperson** will be assistant superintendent of land. **H. W. Pope,** former head of the land department, will remain with the company as consultant and will assist Davis on matters affecting the department's activities.

▸ **Eldon V. Hunt** resigned as chief engineer of the Alberta Gas Trunk Line Company of Calgary, Alberta, Canada, and joined the staff of Ebasco Services, Inc., of New York City. His new position is assistant construction manager in charge of pipe line and related activities throughout the country. He has been in gas and pipe line engineering, construction and operations for more than twenty years and was with Ebasco before as a construction superintendent.

E. V. Hunt

▸ **John Wilbor** has been appointed manager of supply and distribution of the 16-state Central region of Socony Mobil Oil Company, Inc. Succeeding Wilbor as manager of the Chicago division is **Arthur C. Nelson,** who was manager of the Detroit district of Socony Mobil's White Star division. Other promotions include: **Walter A. Guthrie,** Pontiac, Michigan, district manager, succeeds Nelson. **A. G. Epkar,** Toledo, Ohio, district manager, succeeds Guthrie. **John F. Fast,** assistant district manager of the Toledo district, succeeds Epkar.

▸ Appointment of **John H. Osborne** as chief dispatcher, eastern products division of The Buckeye Pipe Line Company, with headquarters in Macungie, Pennsylvania, has been announced. Osborne succeeds the late **Boyd Ozment.** Osborne joined Buckeye in 1952 as a scheduling dispatcher, after 12 years service with The Atlantic Refining Company and Keystone Pipe Line Company in Philadelphia.

▸ Vice President Harrison B. Haney of Tide Water Associated Oil Company has been appointed manager of transportation of the company. In this post Haney is responsible for planning and coordination of all company transportation activities, including pipeline and marine operations.

H&M PIPE CUTTING AND BEVELING MACHINES

Trademark Registered

LIGHT as a feather-

TOUGH as a boot!

Full Range of Sizes
4" to 36"

★ ACCURATE: to the finest detail, any bevel angle, size or shape.

★ SIMPLE TO OPERATE: a few minutes instruction for any operator, for cuts of any shape or angle.

★ PROFITABLE: cuts labor and gas as much as 50%.

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★ SPEEDY: cut and bevel any pipe in minutes!

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★ SHAPE CUTTER — for all types of pipe fabrication.

★ "OUT-OF-ROUND" — for perfect cuts on "out-of-round" pipe.

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Precision-engineered for heavy duty work under most difficult shop and field conditions, H & M Pipe Cutting and Beveling Machines — regardless of size — are increasing in demand *wherever pipe is used.* The trademark of H & M is your constant assurance of dependability backed by service — *imperative to profit* on your jobs.

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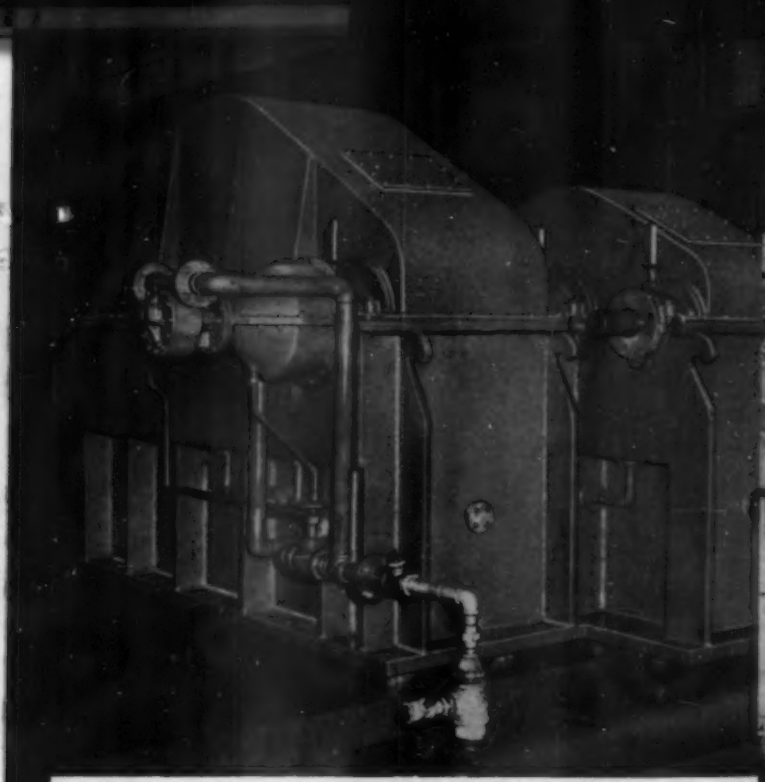
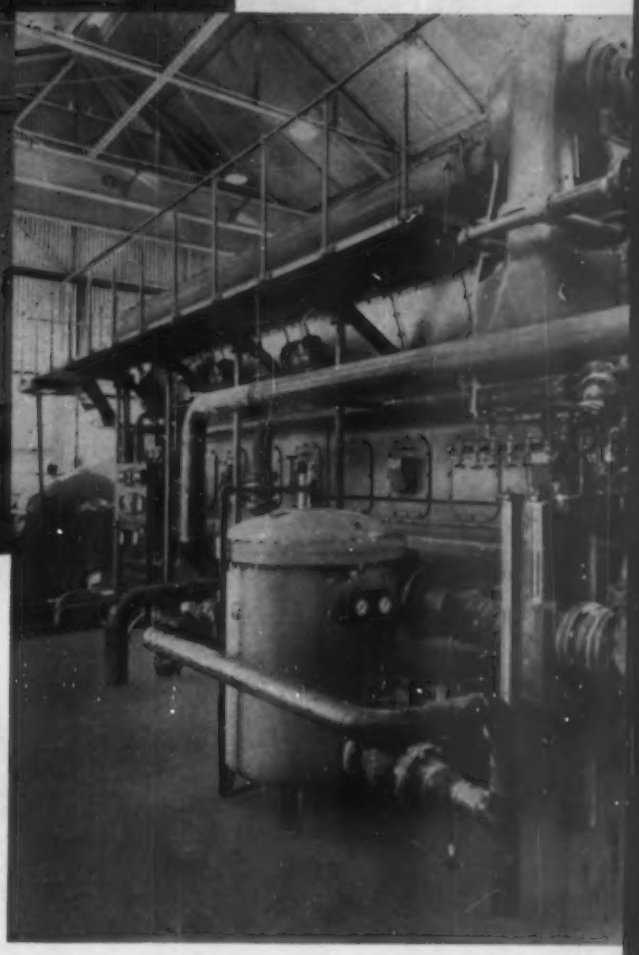




"Satellite" pipeline station, remotely controlled, uses Western Gear two-stage high speed drive

REMOTE CONTROL operation from a point many miles away is a notable feature of the isolated Gulf-Interstate Gas Company's gas line pumping station near Stanton, Kentucky. Another modern feature is its two-stage high speed unit especially designed and manufactured by Western Gear, shown at upper left. This "custom-engineered" unit is driven by a Cooper-Bessemer 16-cylinder engine operating on natural gas from the pipeline. The engine speed of 360 RPM is stepped up by the high speed unit with a ratio of 16.8:1 driving the centrifugal compressor at 6,055 RPM. The entire pipeline station can be placed into operation and completely controlled by a telemetering system miles away.

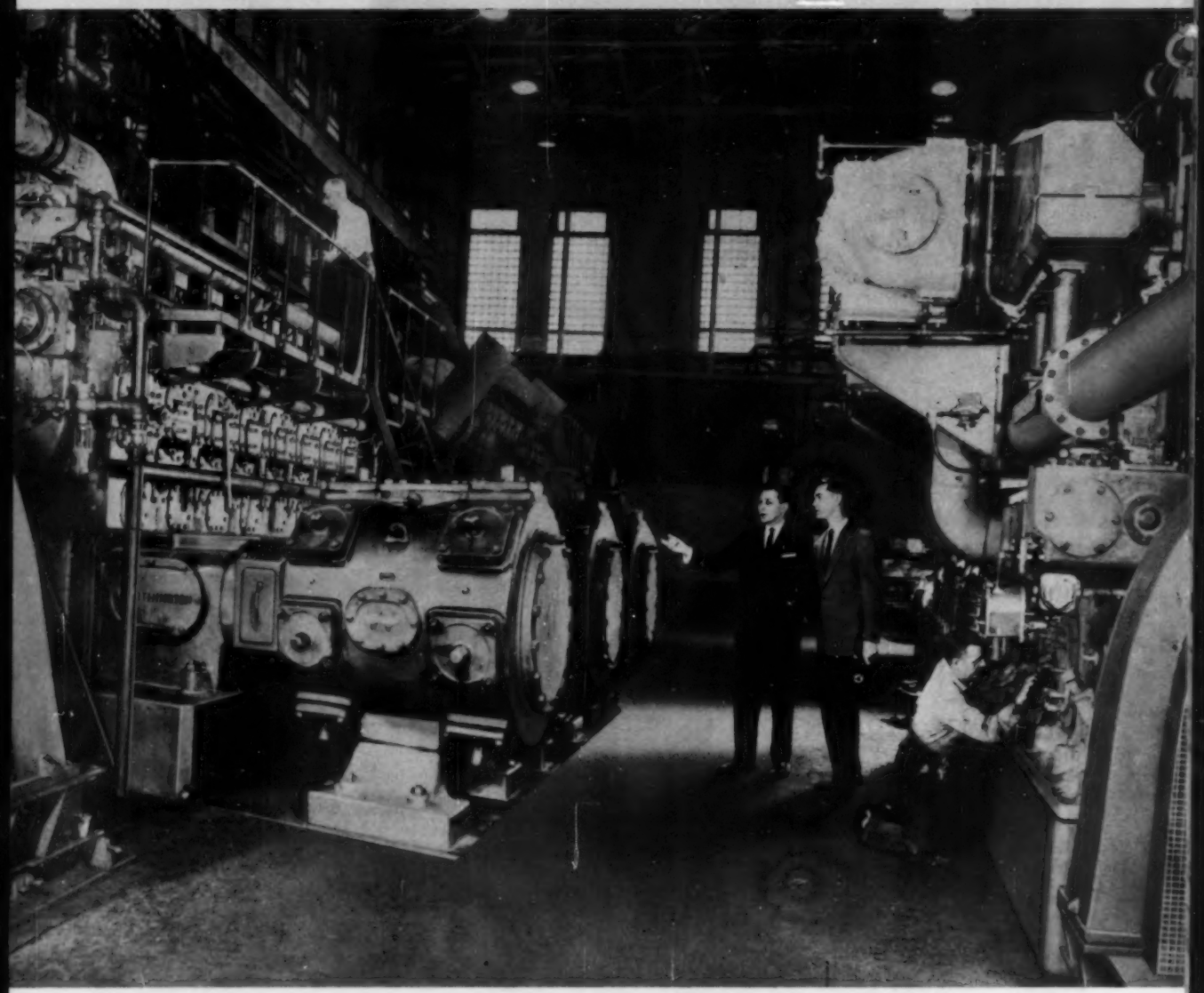
Pipeline experts consider this station one of the most modern and advanced systems of its kind to date. Western Gear's long experience, dating back to 1888, made it the logical choice to design and build the high speed unit so essential to efficient performance of this significant installation. This experience is always available and Western Gear engineers are glad to help solve any problem involving mechanical power transmission equipment for the petroleum industry. Write General Offices, Western Gear Corporation, P. O. Box 182, Lynwood, California.

"The difference is reliability" • *Since 1888*

PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.), SEATTLE AND HOUSTON
REPRESENTATIVES IN PRINCIPAL CITIES

WESTERN GEAR Corporation
ENGINEERS AND MANUFACTURERS

First 2-cycle pipeline compressor with



Progressive engineering gives you more for your engine compressor dollar in the TURBO-UNIFLO

AFTERCOOLING FOR MAXIMUM LOAD CAPACITY. Air inlet manifold temperatures must be kept reasonably low to maintain wide engine operational range and overload capacity. This is important in high ambient temperature locations. Low cycle temperatures reduce maintenance on liners, heads, and pistons. Individual aftercoolers mounted immediately adjacent each cylinder inlet give maximum load capacity with accessibility.

MORE POWER FROM TURBO-UNIFLO DESIGN. Only cam-operated, timed exhaust valves permit early opening of exhaust to give complete evacuation of burnt gases, and controlled closing for trapping maximum supercharging air. Coupled with pulse-generator ignition, this quiet chain driven timing system gives top performance with minimum maintenance.

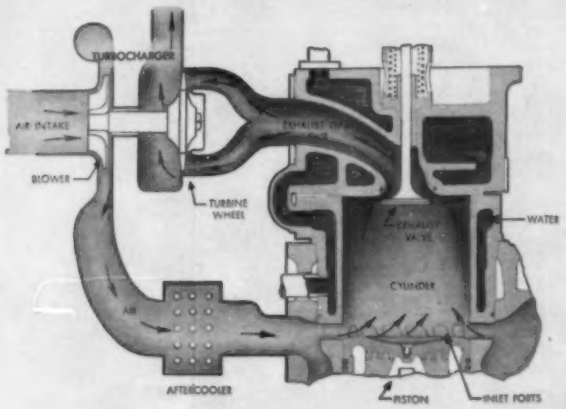
The only turbocharged 2-cycle engine-compressor with

exhaust-powered turbocharging at all loads

NO POWER-DRAINING EXTRA-DRIVE FOR SUPERCHARGING WITH THE "TURBO-UNIFLO"— WORTHINGTON'S SUTC GAS-ENGINE COMPRESSOR

In its first production year this unique two-cycle turbocharged gas-engine-compressor (750 to 2500 hp) has had remarkable acceptance. Designed for quiet exhaust powered pulse-type turbocharging, on the basis of Worthington's extensive two-cycle engine-compressor experience, more than twenty-four TURBO-UNIFLO SUTC's are either installed or on order. Built to lead the field for years to come, they're industry's best for gas pipeline applications.

By integrating exhaust powered turbocharging with field proven Worthington Uniflo scavenging design, Worthington engineers have developed a two-cycle engine-compressor unequalled for stability of performance over the *complete* range of speed and load requirements. Operating at relatively high compression ratio, the TURBO-UNIFLO has much smoother combustion characteristics than other engines with lower compression ratios. This is due to the basic timing arrangement, engine configuration, and design of exhaust manifolding. Sufficient exhaust gas energy is applied at the turbocharger, from engine start-up through all speeds and loads, to give full turbocharged effect without added external mechanical means for driving the supercharger. Low fuel and lube oil consumptions are other important results of this design arrangement.



TURBO-UNIFLO OPERATION — Exhaust valves are timed to open and generate a pressure pulse to move the turbine blades. This gives self-sustained starting and quick acceleration without external aid or mechanical drive. Blower delivers air under pressure to the aftercooler. Cooled air enters the cylinders through inlet ports 360° around the liner. During the scavenging period, the combustion chamber walls and valves are effectively cooled.

The Uniflo system is accepted as having highest scavenging efficiency. It also gives the best turbocharging-scavenge ratio due to complete absence of residual gases in the combustion chamber.

QUIETER OPERATION. Cast-iron exhaust manifolding—dry insulated, built-in air-pulse dampener, triple-strand silent camshaft chain, hydraulic valve lifters and elimination of any mechanically-driven air charging device assure quietness.

FEATHER VALVE. The feather valve is standard TURBO-UNIFLO equipment. It's the lightest, simplest and quietest valve—and operates with no impact!

For more details on the TURBO-UNIFLO, call your nearest Worthington District Office, or write Section E63, Worthington Corporation, Harrison, New Jersey. E-6.3

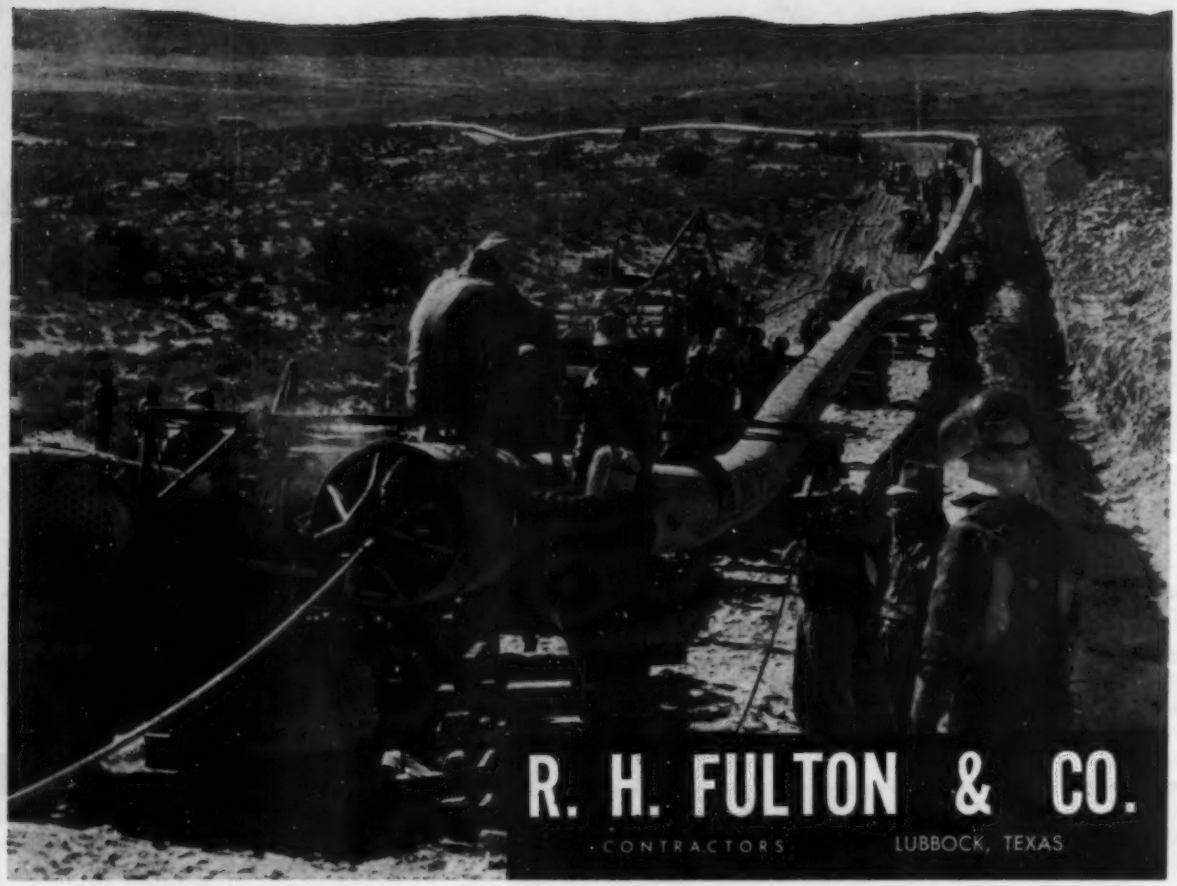
WORTHINGTON

exhaust-powered turbocharging from start-up through full-load

PIPELINES

ACROSS THE NATION...

OIL LINES
WATER PIPELINES
RIVER CROSSINGS
PRODUCTS PIPELINES
GAS PIPELINE CONSTRUCTION



WHAT'S NEW AT BRISTOL...

RIDING 250-MILE PIPELINE from his desk at Charlotte, N. C., Piedmont's gas dispatcher makes instant decisions with aid of this battery of 1- and 2-pen Bristol recorders. They show pressure, temperature and flow at 46 remote points.

Takes 46 readings over 250-mile pipeline with only 4 wire circuits

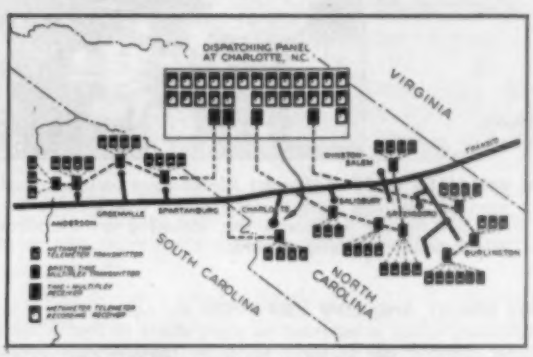
Piedmont Natural Gas Company is first to use new Bristol Intermediate Time-Multiplexing system

With the new Intermediate Time-Multiplexing system, only four leased wire circuits are needed to send readings from 46 telemeter transmitters along Piedmont's 250-mile pipeline to a central dispatching headquarters at Charlotte, N. C.

The close continuous supervision provided by the new Bristol instrumentation system enables operation of Piedmont's complex gas distribution facilities at nearly 99% load factor.

Multiplexed Bristol Metameter Telemeters provide transmission of up to 15 instrument readings over a single wire circuit. With the new Intermediate Time-Multiplexing, these readings may be multiplexed onto the line at *widely separated intermediate stations*—effecting great economies in the number of required circuits.

Find out how these Bristol Metameter Telemeters can solve *your* complex telemetering problem in the most economical manner. Write The Bristol Company, 144 Bristol Road, Waterbury, Conn. A45



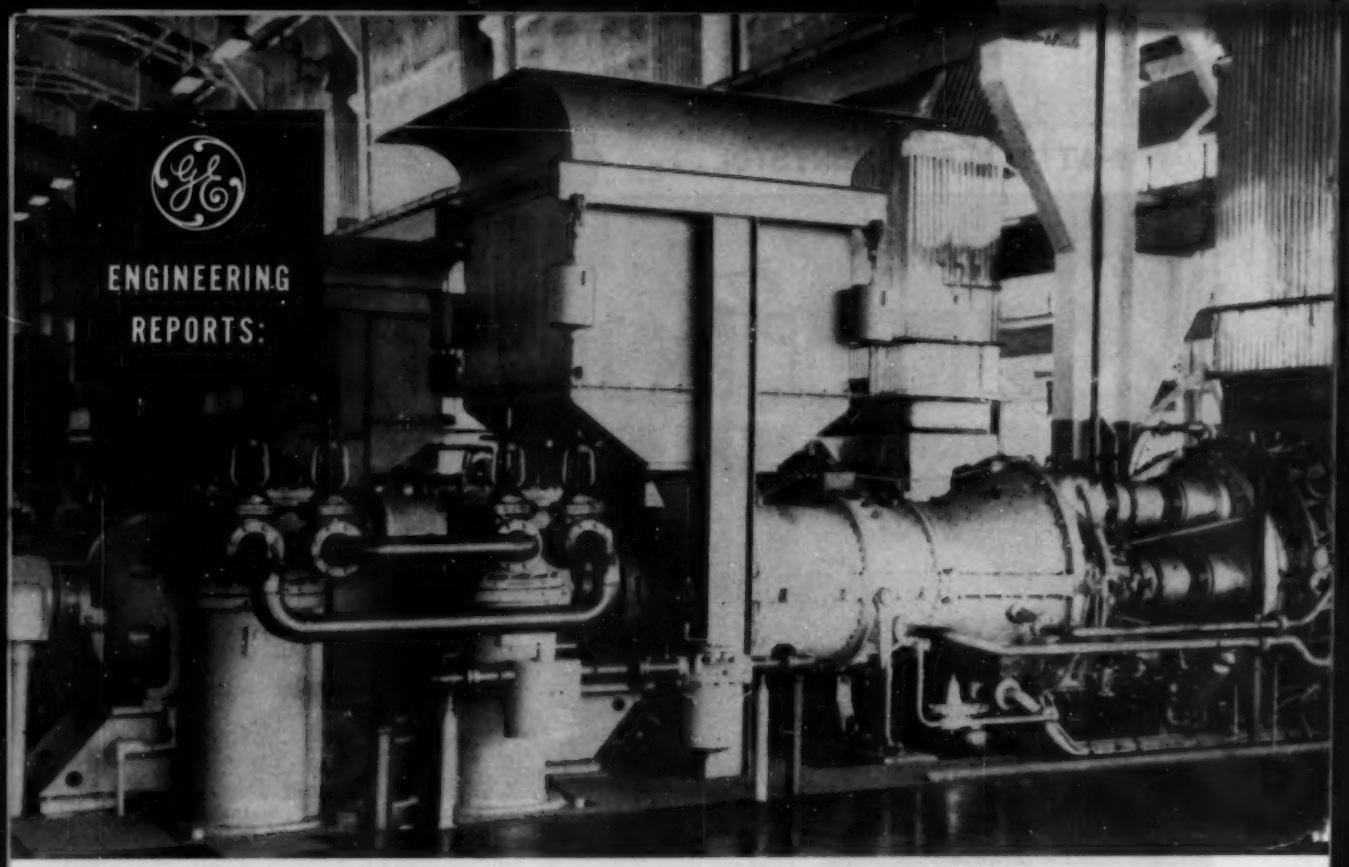
TWO-STATE COVERAGE with only four leased telephone circuits is effected by this instrumentation system. Note that as many as four intermediate time-multiplex transmitters add readings to a single circuit at different points.

BRISTOL

BRISTOL'S

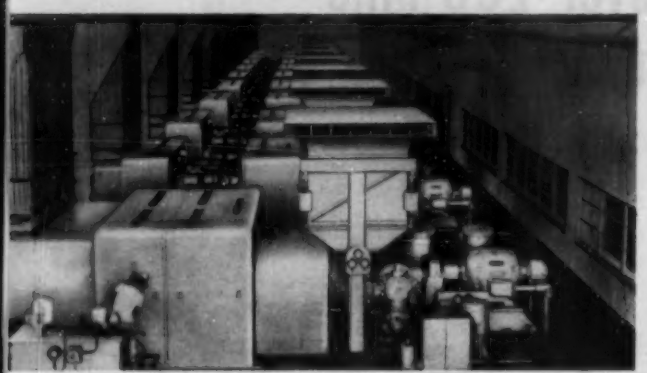
POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS



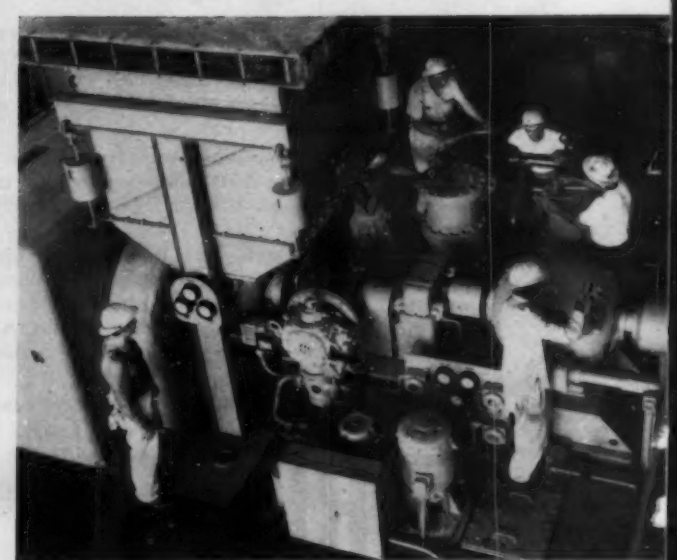
In first 13 months of operation at Lake Maracaibo...

Creole Petroleum's log 89,000 hours

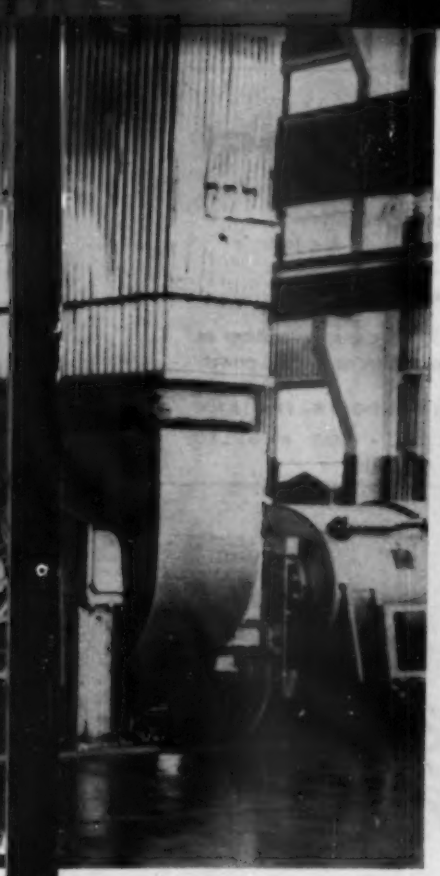


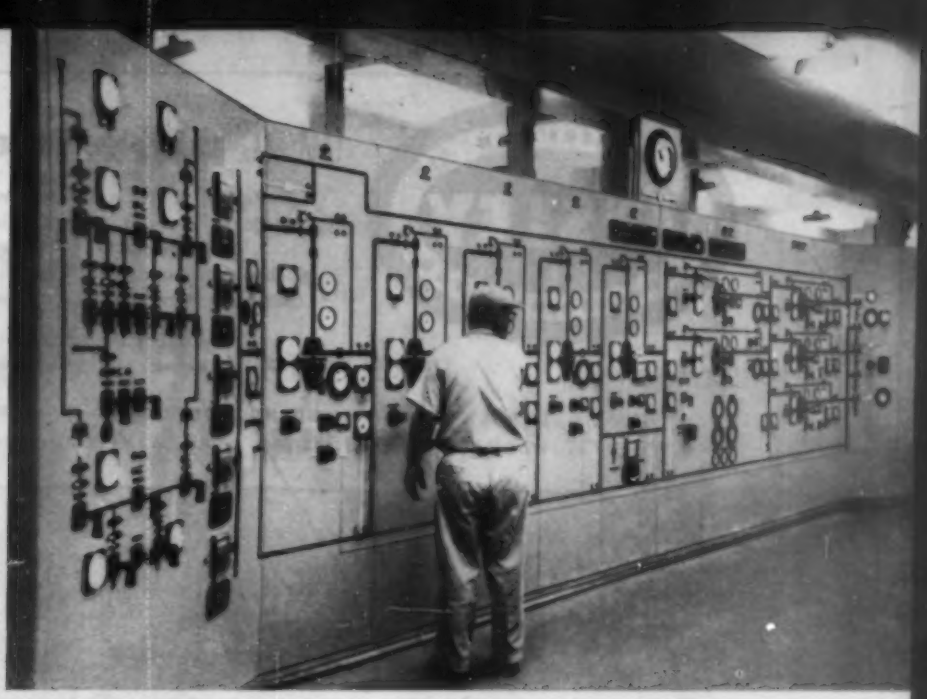
LOW INSTALLED COST of General Electric gas turbines results from ease of handling during installation. Gas turbine units up to 13,000 hp are self-contained, mounted on foundation bases which double as shipping skids.

LIGHT WEIGHT AND LOW VIBRATION are essential to Creole installation, which is mounted on piers above 60 feet of water. General Electric gas turbines fill these requirements because components are compact with minimum vibration.



SYSTEM-ENGINEERED G-E gas turbines—shown here during installation—include fully integrated starter motors and assemblies. All ten turbine-compressor units in the Lake Maracaibo plant can be started and put on the line in about ½ hour.





CENTRALIZED CONTROL of practically all station functions is combined in main General Electric control panel. Turbines, compressors and valves are directed from this board.

SEMI-AUTOMATIC OPERATION of G-E gas turbines means a minimum of operating and supervisory expense. Need for separately mounted auxiliary pumps and blowers is eliminated because of completeness of units.

10 General Electric Gas Turbines —— with an availability of 98%

Creole Petroleum operates their Tia Juana No. 1 Conservation Plant on a platform over Lake Maracaibo in Venezuela—in the midst of its offshore oil fields. Ten General Electric 6000-hp combustion gas turbines —heart of the plant—power centrifugal reinjection compressors to conserve the gas and to increase the yield from these gigantic fields. This installation represents the largest concentration of gas-turbine horsepower in the world.

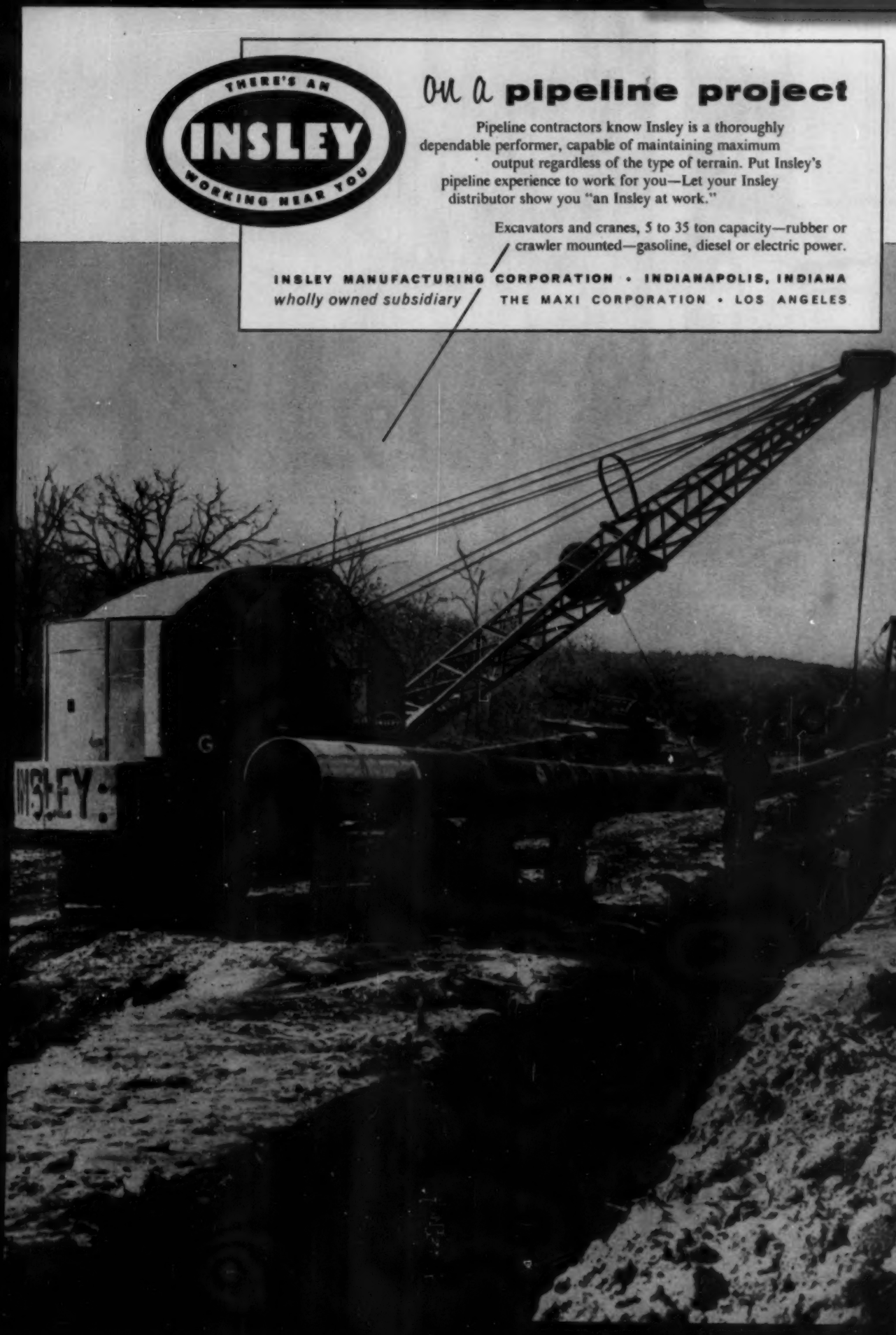
IN THEIR FIRST 13 MONTHS of operation, ten G-E units operated a total of more than 89,000 hours. Except for planned maintenance, the platform has never had to be shut down due to a gas-turbine outage, and availability has averaged 98% for the ten General Electric gas turbines. When sufficient gas has been available, the plant has *consistently* re-injected more than its planned capacity of 137 million standard cubic feet per day. During one week, the platform averaged 170.8 million cubic feet per day.

THE SUCCESS of this unique installation resulted from the close co-operation between Creole, their consultants—Esso Research and Engineering for process engineering and Brown and Root, Inc., for construction engineering—and G-E engineers. Creole's installation is an outstanding example of Petroleum Industry enterprise and represents a new concept in oil field pressure maintenance.

Creole is also a good example of how G-E engineering services can help you and your consulting engineer plan and install an engineered electrical system for your specific need. For more information about General Electric engineering services and electrical equipment, contact your nearest G-E Apparatus Sales representative and write for Bulletin GEA-5962 to General Electric Co., Section 661-53, Schenectady 5, N. Y.

Engineered Electrical Systems for the Oil and Gas Industries

GENERAL ELECTRIC



on a pipeline project

Pipeline contractors know Insley is a thoroughly dependable performer, capable of maintaining maximum output regardless of the type of terrain. Put Insley's pipeline experience to work for you—Let your Insley distributor show you "an Insley at work."

Excavators and cranes, 5 to 35 ton capacity—rubber or crawler mounted—gasoline, diesel or electric power.

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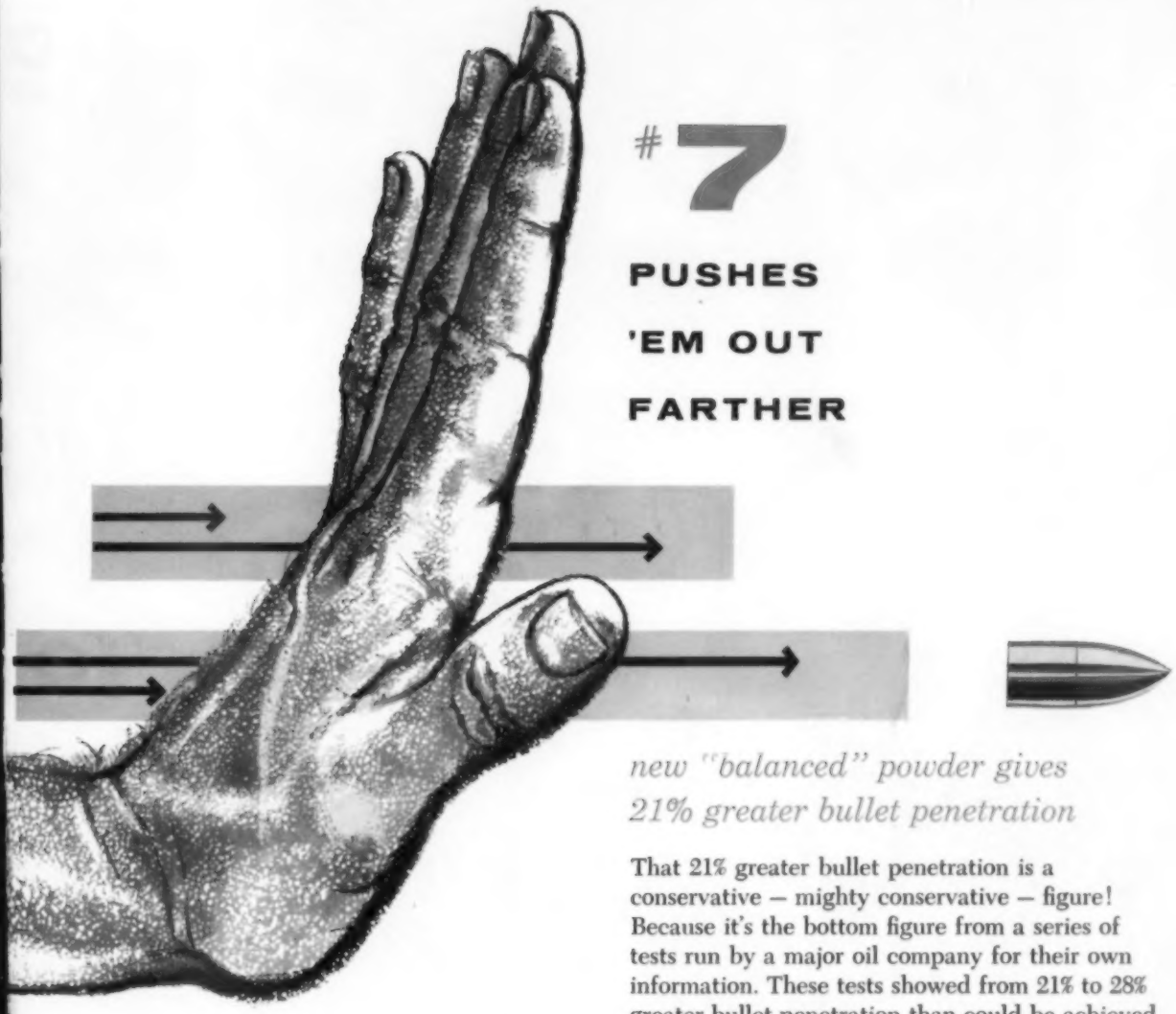

#7

PUSHES 'EM OUT FARTHER

new "balanced" powder gives 21% greater bullet penetration

That 21% greater bullet penetration is a conservative – mighty conservative – figure! Because it's the bottom figure from a series of tests run by a major oil company for their own information. These tests showed from 21% to 28% greater bullet penetration than could be achieved with Lane-Wells #3 powder – and that was powerful powder, as the same tests showed. Lane-Wells new #7 powder is a new answer to the age-old ballistics problem of how to get more power behind the bullet without increasing the strain on the gun. #7 has been so formulated and "balanced" that it burns slower, with lower peak pressure, but *longer* . . . thus building up a tremendous "push" behind the bullet that drives it deeper into the formation. And there's no price premium for #7 powder – just another example of Lane-Wells efforts to give better service.

Tomorrow's Tools – Today!®

LANE WELLS COMPANY

General Offices, Export Office, Plant • 5610 So. Soto St., Los Angeles 58

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Why One Source for All Six?

Well completion is a joint effort. One thing leads to another, and each step requires close coordination. Isn't it better and easier for you to call in one good source for all six services than to coordinate the efforts of many "one-service" companies—especially since each will have a natural reason to emphasize its own contribution?

The six services Halliburton provides are important, necessary and closely integrated. Each one helps the other to put more oil in your tanks. And each service is supported by Halliburton's 3 million job experience, 30 year's intensive research, and the policy of performing service beyond the fee—service above all.

You can be sure of perfect coordination when you call in the one good source for all six well completion services.

HALLIBURTON OIL WELL CEMENTING COMPANY

DUNCAN, OKLAHOMA

"PROGRESS IN SERVICE THROUGH RESEARCH"